125 MHz Pulse Generator
PM 5786

Service Manual

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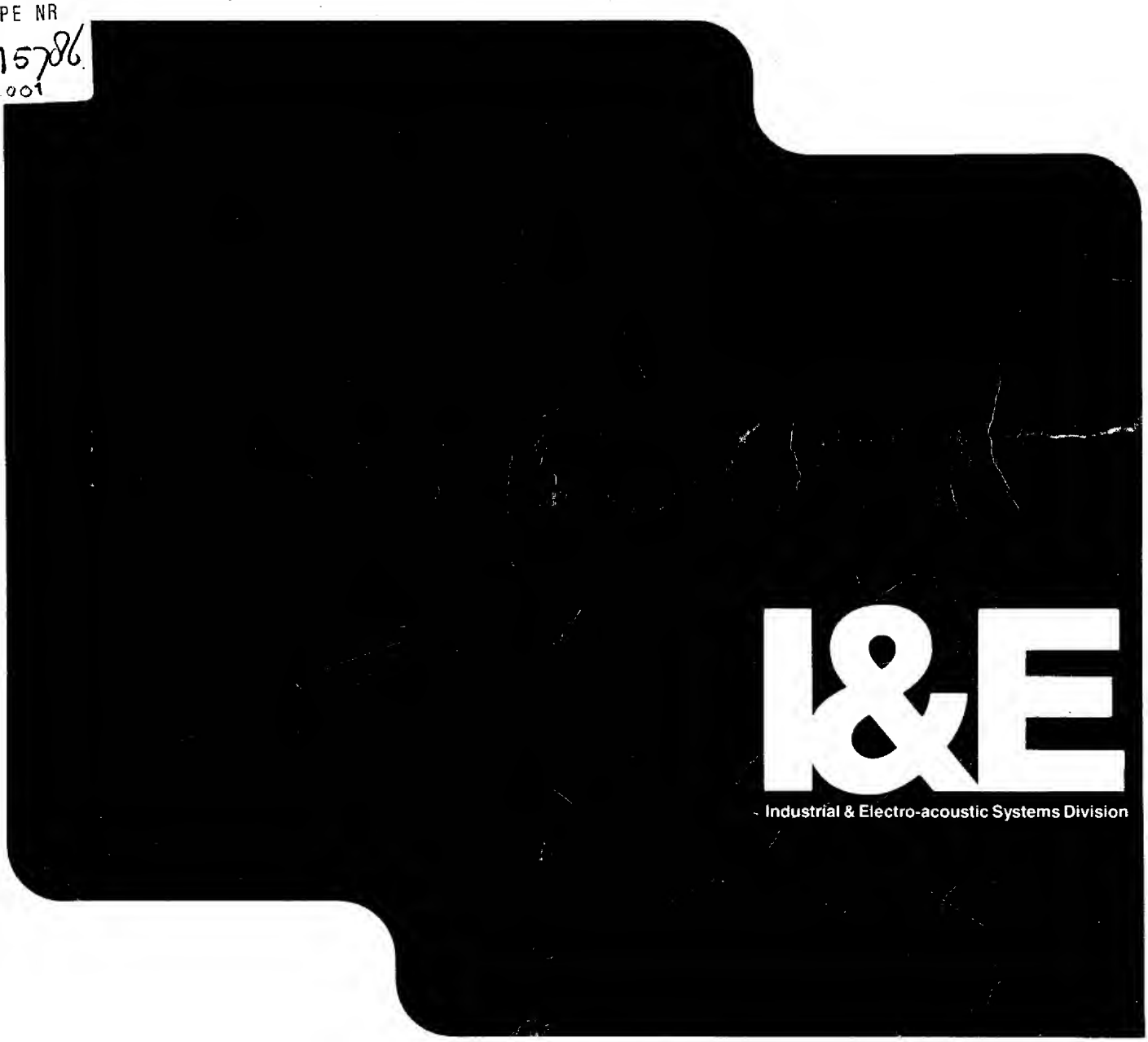

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125 MHz Pulse Generator

PM 5786

Service Manual

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CONTENTS

Chapter 1

SAFETY INSTRUCTIONS

CONTENTS

GENERAL INFORMATION

WARNING: These servicing instructions are for use by qualified personnel only. To reduce the risk of electrical shock, do not perform any servicing other than that specified in the Operating Manual unless you are fully qualified to do so.

This pulse generator has been designed and tested in accordance with IEC Publication 348, Safety Requirements For Electronic Measuring Apparatus For Class 1 instruments, and has been supplied in a safe condition. This manual contains information and warnings that should be followed by the user and service technician to ensure safe operation and repair in order to keep the pulse generator in a safe condition.

WARNING: The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can be dangerous to life.

The pulse generator must be disconnected from all voltage sources before it is opened.

Remember that capacitors inside the pulse generator retain their charge even if the pulse generator has been disconnected from all voltage sources.

GROUNDING

The pulse generator is connected to ground via a sealed three-core power cable, which must be plugged into a socket outlet with a protective ground contact. No other method of grounding is permitted for this pulse generator. When the pulse generator is brought from a cold to a warm environment, condensation may cause a hazardous condition. Therefore, ensure that the grounding requirements are strictly met.

Power extension cables must always have a protective ground conductor.

WARNING: Any interruption of the protective ground conductor inside or outside the pulse generator, or disconnection of the protective ground terminal, is likely to make the pulse generator dangerous. DO NOT intentionally disrupt the protective grounding.

LINE VOLTAGE SETTING

Before connecting the pulse generator to the line, ensure that it is set to the local line voltage. On delivery the pulse generator is set to either 100 V, 120 V, 220 V or 240 V, as indicated on the line voltage selector on the rear panel. If the voltage setting is incorrect, set the line voltage selector in accordance with the local voltage before connecting the pulse generator to the line. See Operating Manual, Fig. 2.2.

REPLACING COMPONENTS IN THE PRIMARY CIRCUITS

Components that are important for the safety of the instrument may only be renewed by components obtained from your local Philips organisation.

After repair and maintenance in the primary circuit, safety inspection and tests, as described in Chapter 5, have to be performed.

FUSES

The pulse generator is protected by three fuses. One ordinary fuse and two thermal fuses. The ordinary fuse has to be replaced when the line voltage setting is changed. For 220 V, use a 0.8 A slow-blow fuse and for 115 V, a 1.6 A slow-blow fuse. Disconnect the power plug before replacing a fuse. Ensure that only fuses of the specified type are used.

NOTE: A 6.35x32 mm fuse can also be used if the fuse-holder in BU3 is replaced. One such fuse-holder is included at the delivery of the instrument.

See Chapter 7 for spare part ordering numbers.

Chapter 2

SERVICING PHILOSOPHY

CONTENTS

PRELIMINARY INVESTIGATION WITHOUT OPENING THE CABINET

A pulse generator is a fairly straightforward product. Basically a pulse is generated at one end of the instrument, it is then modified to the correct shape by a number of function-blocks before it is taken out via the output connector. This makes the instrument easy to fault-find.

It is often possible to find the faulty block just by checking the output signal with an oscilloscope.

That is, when the controls of the pulse generator are set to a predetermined setting, you can compare the pulse on the oscilloscope screen with the correct pulse shape, see the fault-finding tree in Chapter 5 of this manual.

'TRACKING DOWN YOUR SUSPECT' (or a time-saving test method)

This is the true story of how to find your suspect among a crowd of other components.

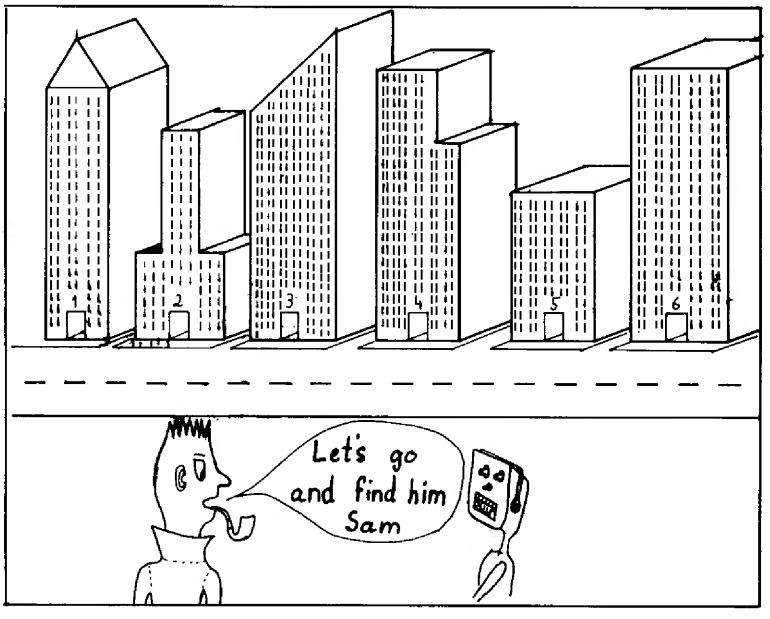
STARRING

The detective: Lester Tester
His assistant: Sam Pling (PM 3400)
Second assistant: PM 5786 Service Manual
The suspect: TS 701

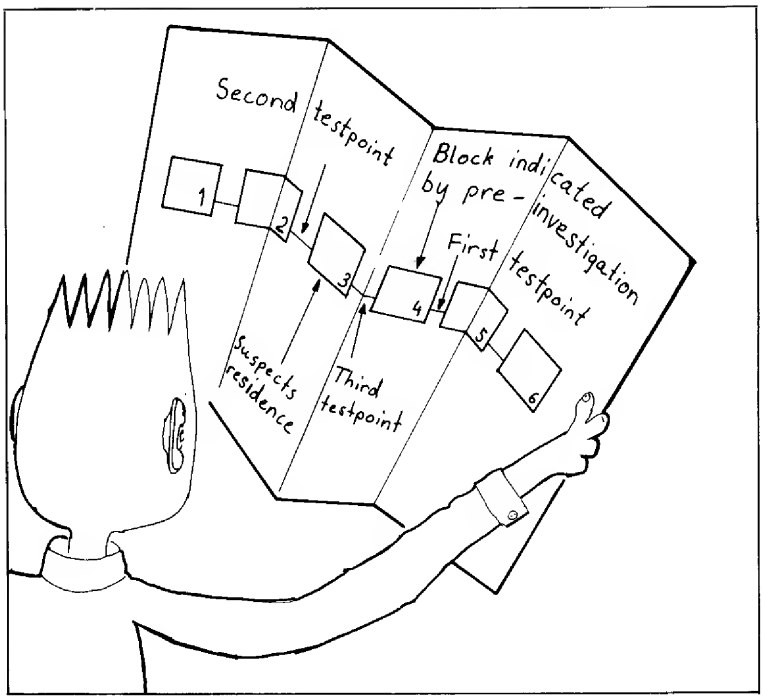
The story was recorded at PM 5786 Studios in the repair workshop.

NOTE: Any resemblance between the components in this story and actual components is purely accidental.

When the preliminary investigation is completed and the suspect block is indicated, check the outputs from that block. If they are correct, check the inputs. In this way, it is possible to detect in which direction the suspect is hiding.

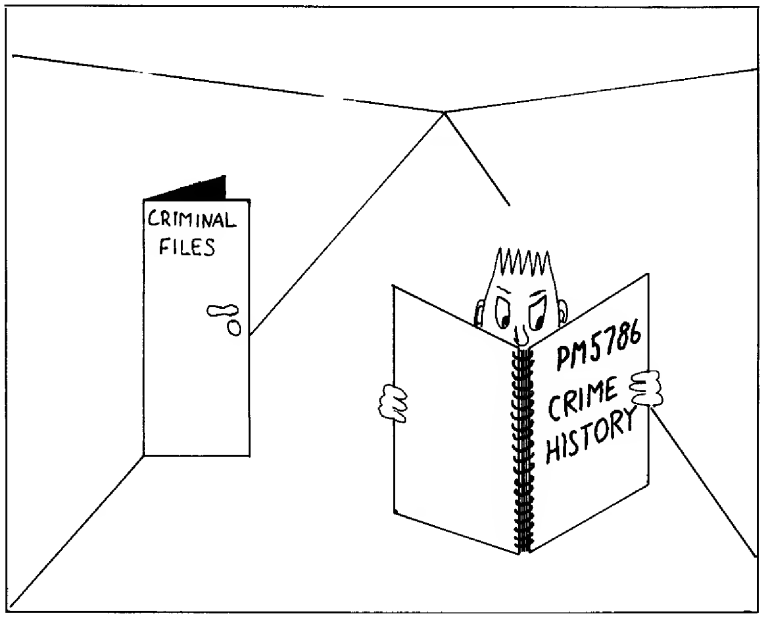


Continue the search half-way from your present test point, and the first block. Then close in on the suspect by dividing the distance again, and so on until you can positively identify which block he is in.

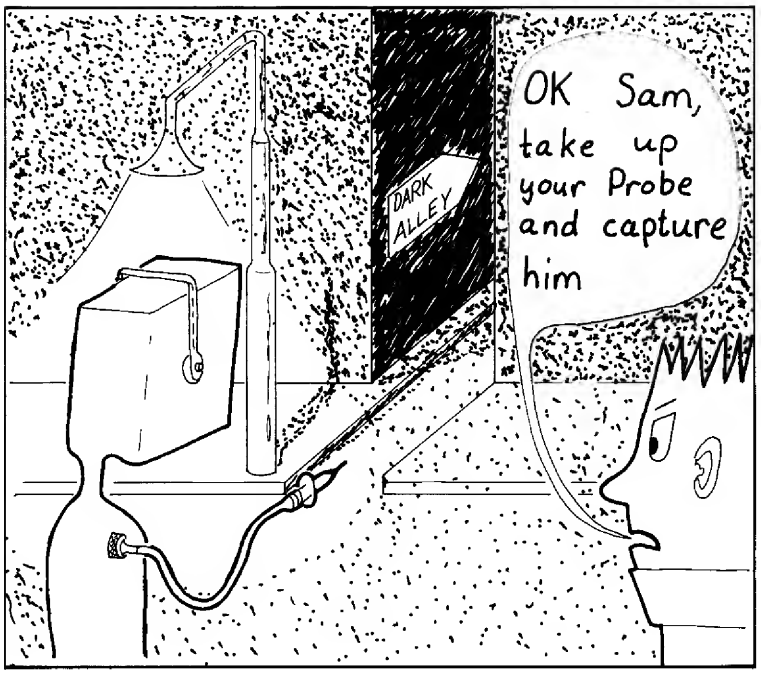


Map of the suspicious area

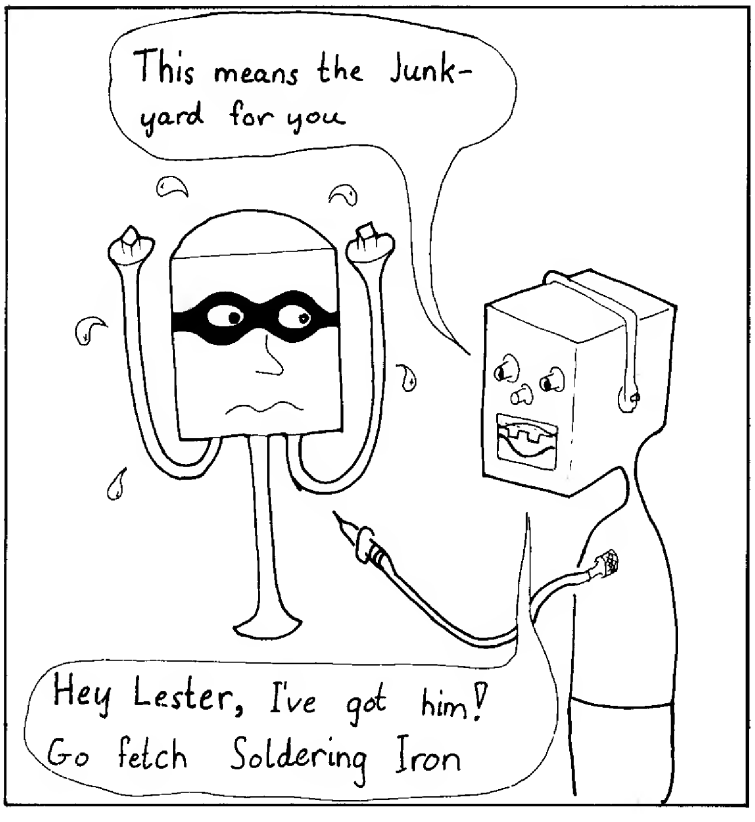
When you have found the whereabouts of the suspect, look for clues on that block in the functional description Chapter 4, before you go after him.



Then start testing all functions in the block until you have the suspect surrounded.



After a positive identification: Eliminate and replace with one of proven character and reliability.



Chapter 3

DISMANTLING AND UNIT EXCHANGE

CONTENTS

DISMANTLING

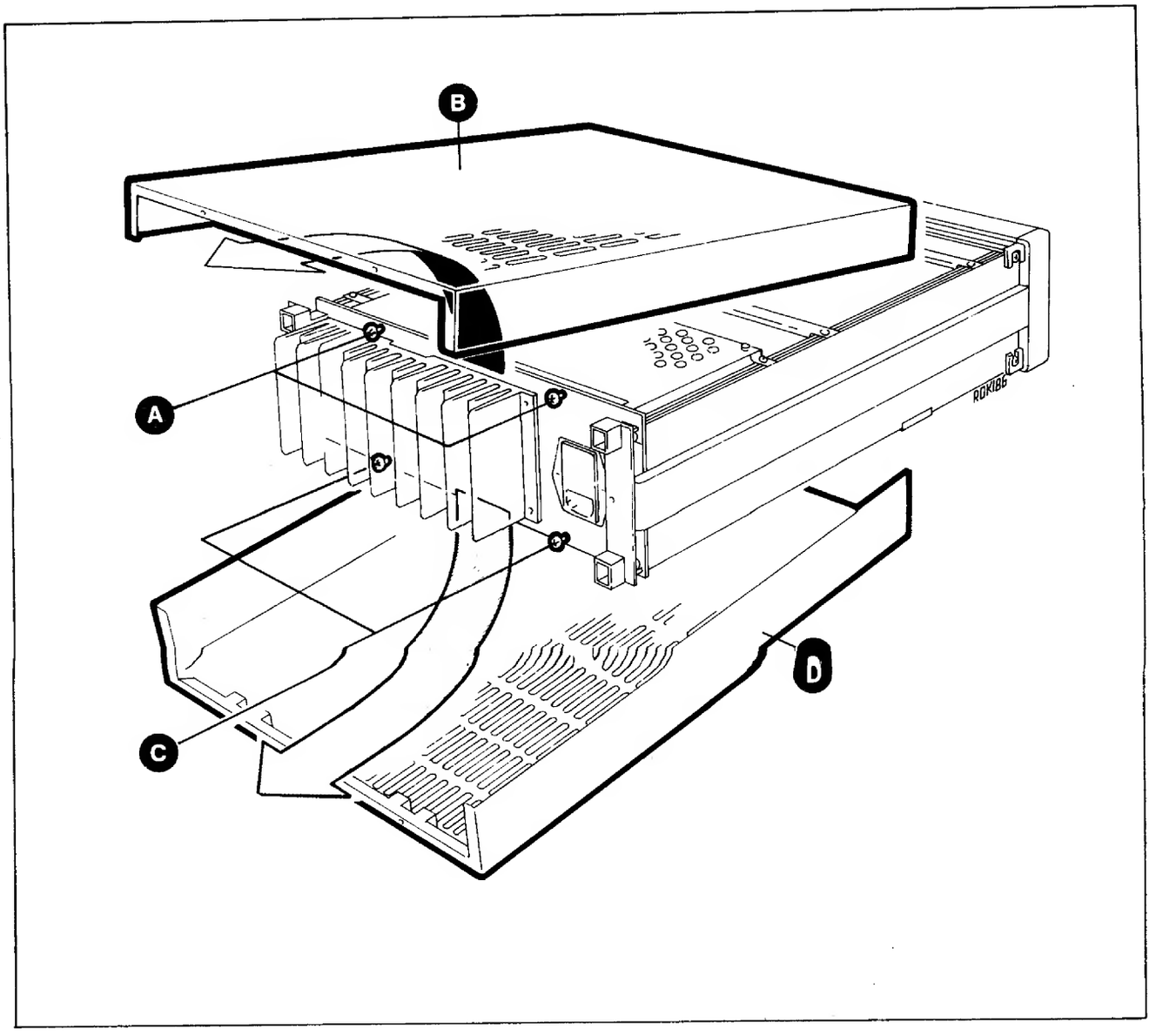
WARNING: The opening of covers, or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can be dangerous to life.

- The pulse generator must be disconnected from all voltage sources before it is opened.
- Bear in mind that capacitors inside the pulse generator can still hold their charge even if the pulse generator has been separated from all voltage sources.

Top and bottom covers

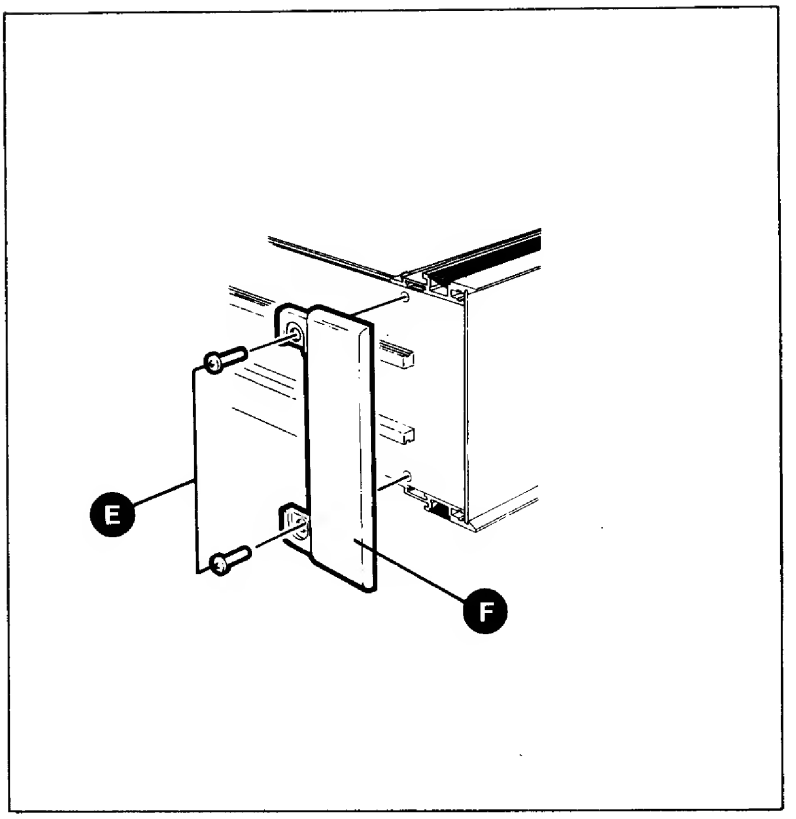
- Disconnect the pulse generator from the power source.
- Loosen the two top cover retaining screws (A).
- Lift up the rear edge of the top cover (B), then pull it backwards.

NOTE: The procedure for removing the bottom cover (C) is the same as the above procedure, except that the pulse generator must first be turned upside down, and screws (D) are loosened.

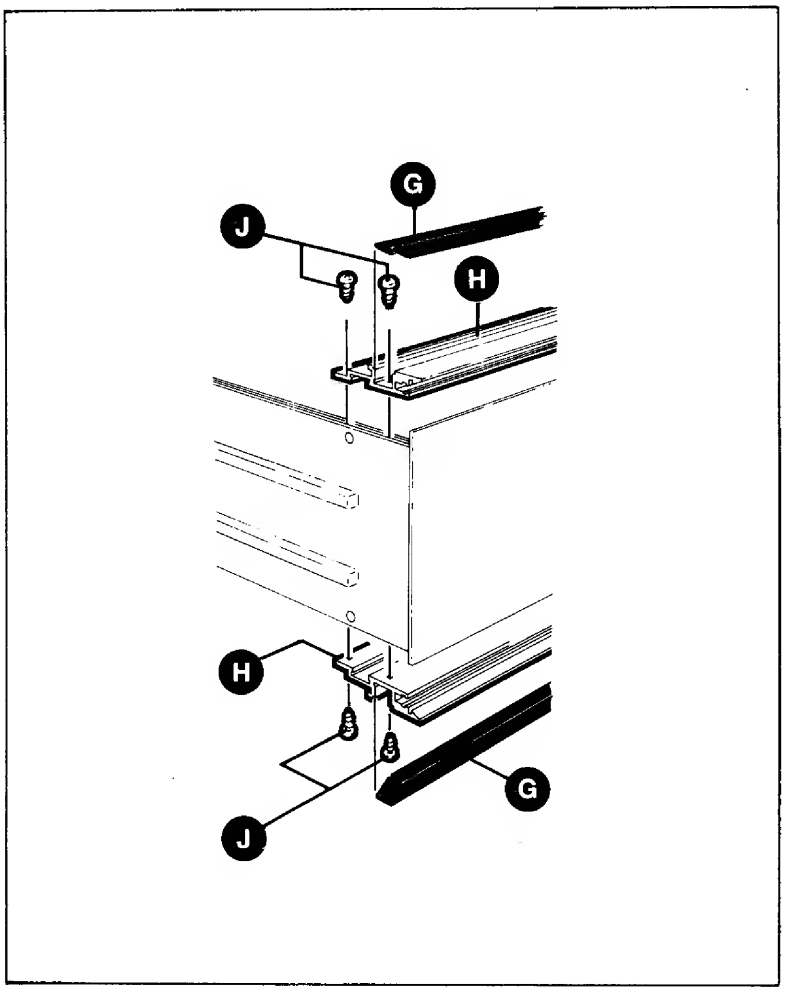


Upper and lower front-panel edging

- Remove the top and bottom covers.
- Remove the two fixing screws (E) for each side piece and lift off the side pieces (F).



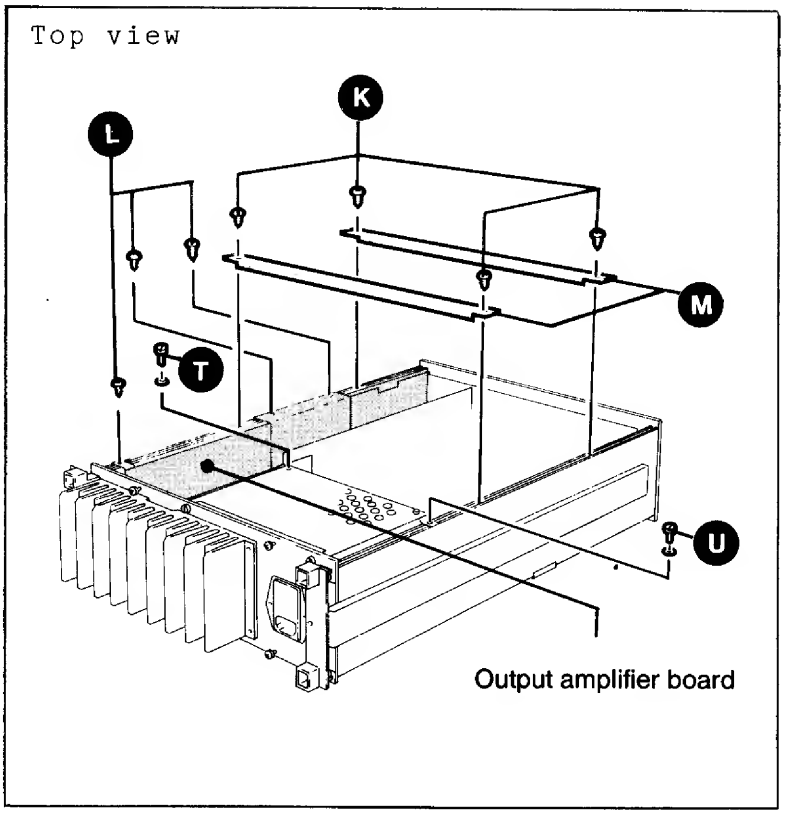
- Remove the brown and black ornamental strip (G) from the upper panel edging (H) and the corresponding strip in the lower panel edging.
- Remove the four fixing screws (J) and lift off the edging.



UNIT EXCHANGE

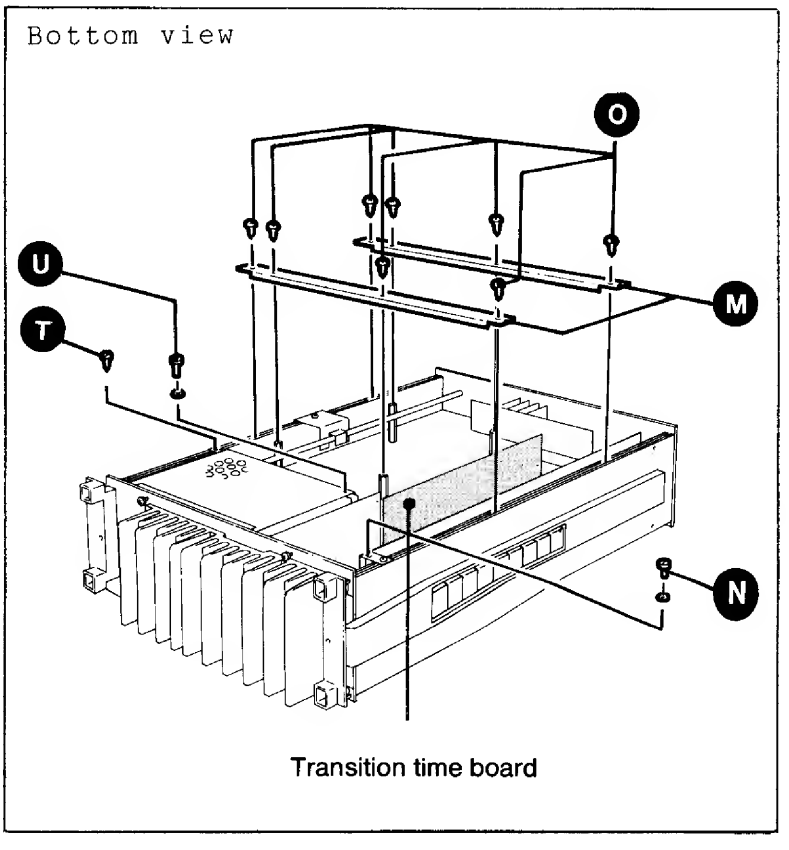
Output amplifier board (Unit 4)

- Remove the top and bottom covers.
- Remove the four screws (K) and the three screws (L) holding the upper two board stabilisers (M) and the output amplifier board.
- Remove the screw (N) on the fixing bracket for the amplifier board.
- Remove the two coax-cables from BU501, 502 and the flat-cable from BU405.
- Pull the board backwards carefully and upwards until it is free.



Transition time board (Unit 3)

- Remove top and bottom cover.
- Remove the four screws (K) and the eight screws (O) holding the four board stabilisers.
- Remove the four board stabilisers (M).
- Remove the coax-cable from BU303 and the flat-cable from BU305.
- Remove the knob and the plastic sleeve from the transition time selector.
- Move the board to the right until it is free.

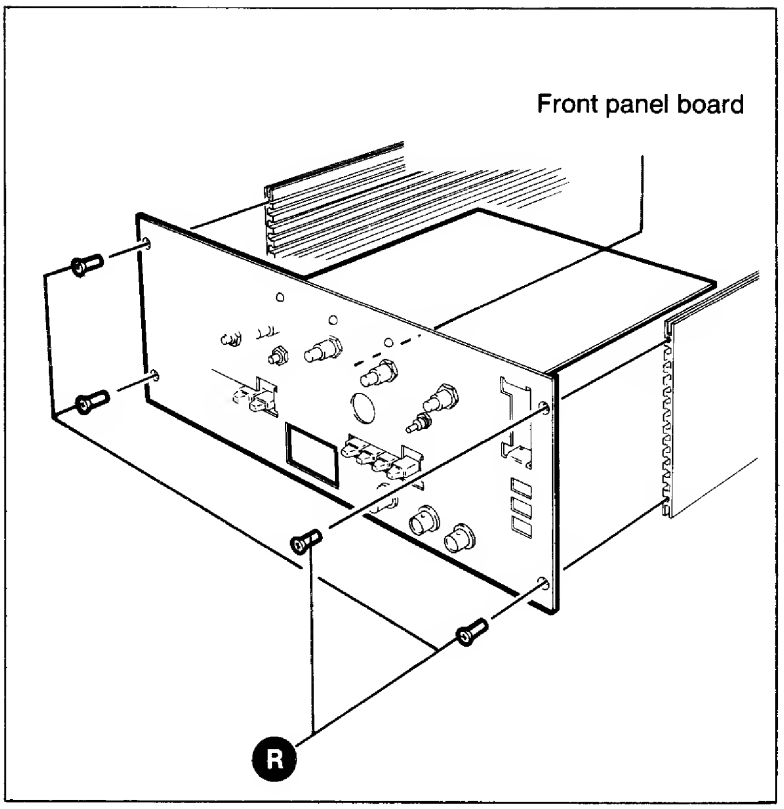


Front-panel board (Unit 6)

- Remove the top and bottom cover.
- Remove the front panel edging, all four pieces.
- Disconnect BU201, BU202 and BU206.
- Remove the three screws (P) holding the front-panel board.
- Raise the pulse generator to an upright position, standing it on the cooling fin.
- Remove all potentiometer and switch selector knobs and remove the text plate.

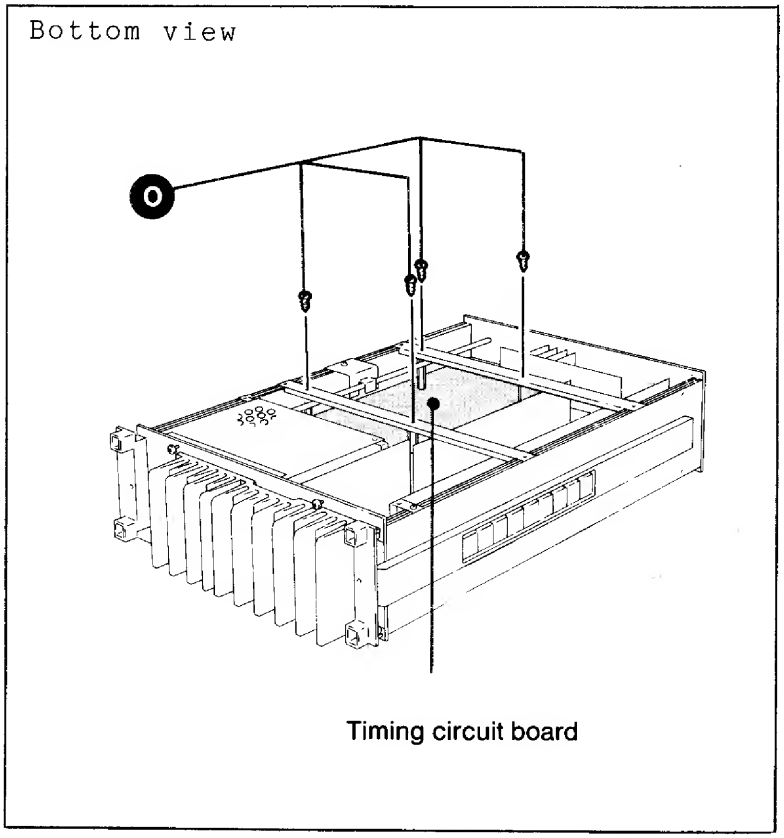
NOTE: On later versions the front-panel potentiometers are mounted through holes in the front-panel board and can be replaced without further dismantling.

- Remove all nuts holding potentiometers and switches.
- Remove the two socket-head cap screws (Q) holding the thumb-wheel switch.
- Release the two LEDs "POWER" and "LEVEL" by releasing the locking rings and pushing the LEDs backwards through the panel.
- Remove the four screws (R) and lift off the front-panel. The potentiometers are now available for replacement.
- If the front-panel board must be removed, bend the transition time board sidewards to open BU302/BU602 and lift off the front-panel board.



Timing circuit board (Unit 2)

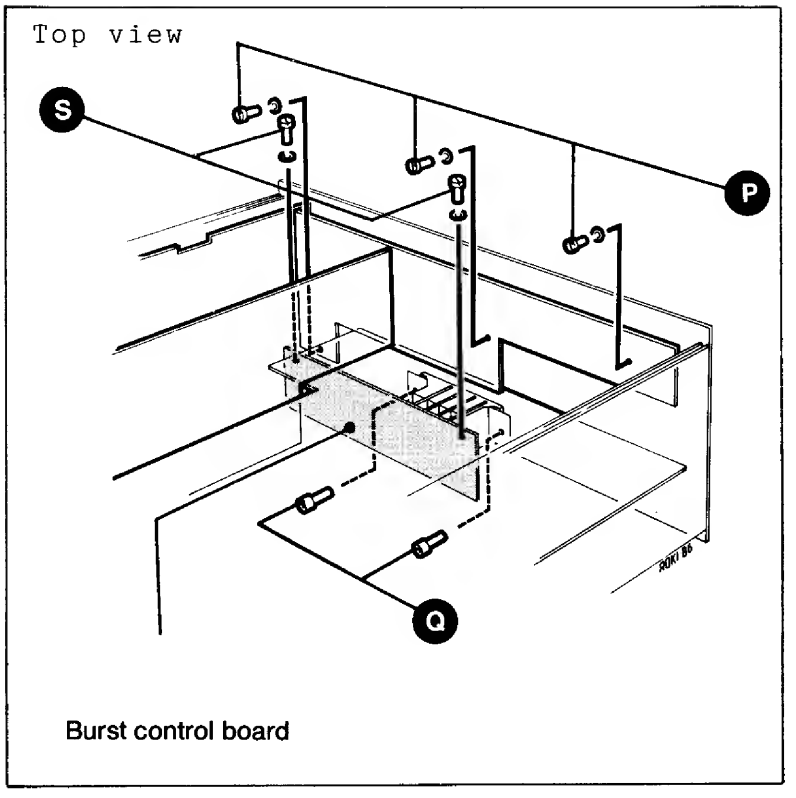
- Remove the front-panel board as described above.
- Remove four of the screws (O) holding the board.
- Remove the board.



Burst control board (Unit 7)

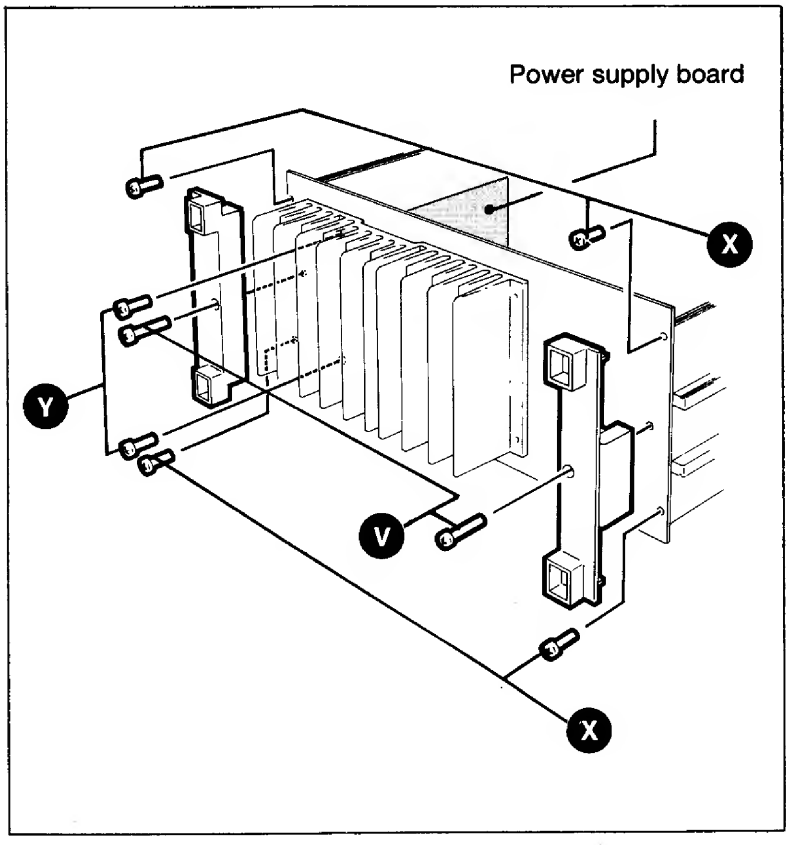
- Remove top and bottom cover.
- Remove both side pieces and the lower front-panel edging as previously described.
- Remove all potentiometer and switch selector knobs and the text plate.
- Remove the two socket-head cap screws (Q) holding the thumb-wheel switch.
- Remove the two screws (S) holding the burst control board.
- Remove the burst control board by carefully pulling it backwards and downwards.

NOTE: It is possible to remove the burst control board without removing the knobs and textplate. However, the connector pins must be bent slightly in order to free them from the connector on U2.



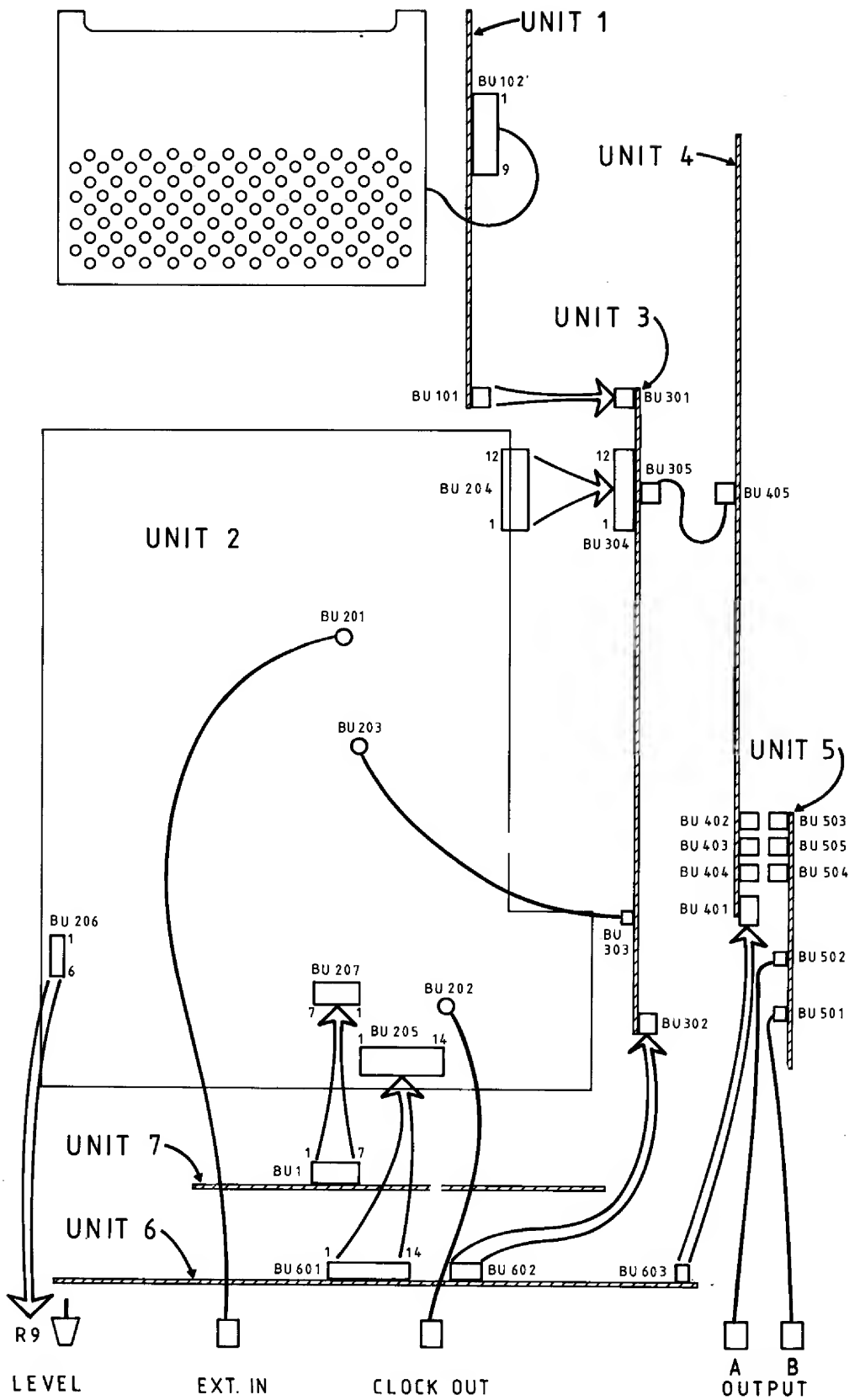
Power supply board (Unit 1)

- Check that the power cord is removed.
- Release the push rod from the power switch; be careful not to damage the switch.
- Remove the two screws (T), see page 3-4, fixing the mains transformer cover to the side pieces.
- Remove the two screws (U), see page 3-4, holding the angle brackets to the transformer cover.
- Remove the two screws (V) holding the rear bumpers and remove the bumpers.
- Remove the four screws (X) holding the rear panel.
- Disengage the connection to the transition time board BU101/BU301.
- Disconnect the cable from BU102.
- Remove the rear panel with mains transformer and the power supply board.
- Remove the two screws (Y) and lift out the board.



INTERCONNECTIONS

Ensure that that the cables always are correctly replaced.



REPAIR HINTS

General

The service kit 4031 100 44300 contains extension cables enabling service of unit 1, 3 or 4 when they are removed from the pulse generator. But remember that the final adjustments must be executed with the unit mounted correctly in place.

Output board

When trouble-shooting the output unit, remove the board and mount it upside-down secured by the two screws in the side piece of the pulse-generator. Use the extension cable during the trouble-shooting, but any adjustment must be performed with the unit mounted correctly in place.

Chapter 4

FUNCTIONAL DESCRIPTION

CONTENTS

BLOCK DIAGRAM DESCRIPTION

The block diagram shows how the different parts of the PM 5786 are connected together. A good understanding of how the pulse generator works is essential for a successful attempt to repair it. Starting from the left, there is:

External input (marked red) with its input amplifier, trigger level setting and slope selection. A LED blinks when triggering takes place. The manual and single functions are created in the same block.

The function selector in the second block enables selection of: internal clock, trigg, gate or burst. From the function selector, the signal passes either as a gate signal to the oscillator, as a trigger signal direct to next function selector, or as a start signal to the burst function (in PM 5786B only).

The internal clock oscillator is combined with decade dividers giving in total nine ranges. The oscillator is either free-running, gated, or gives one burst. In burst mode the start and stop pulses are given by the burst counter.

The second function selector allows the internal clock pulses or external trigger pulses to pass on continuously via the delay and duration circuits. These pulses can also be supplied direct to the duration circuit offering one delayed and one undelayed pulse (double pulse mode). There is also a possibility to allow the clock or trigger pulse to bypass both delay and duration circuits (external duration or square-wave mode).

There is also an output on the function selector giving out the external trigger pulse or the internal symmetrical clock pulse.

The pulse delay circuit will delay the pulse with the set delay-time. The clock output taken out earlier will serve as a time reference or pre-trigger. Note that in double pulse mode it is the second pulse that is delayed and the first pulse that might be omitted. A too long or too short delay-time will be indicated by the error detector.

The pulse duration circuit will receive either the delayed pulse only or, the undelayed and delayed pulses, and give them the set duration. Too long a time will be indicated by the error detector.

The ramp generator will add the variable rise- and fall-times to the pulses. Too long a time will be indicated by the relevant error detector.

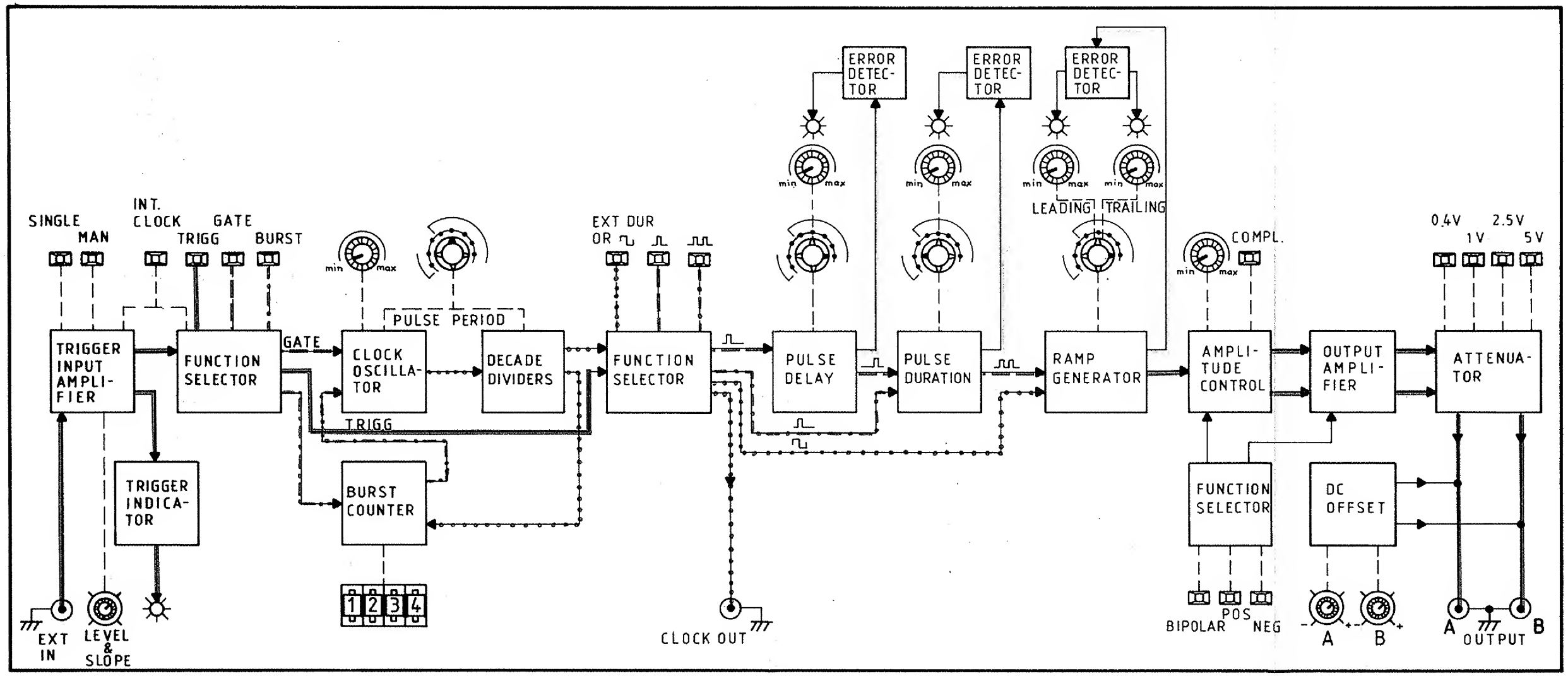
Amplitude control is carried out by variable amplification in the same block used for the selection of normal or complementary pulse.

The function selector connected to amplitude control and output amplifier works with several current generators and inverting functions.

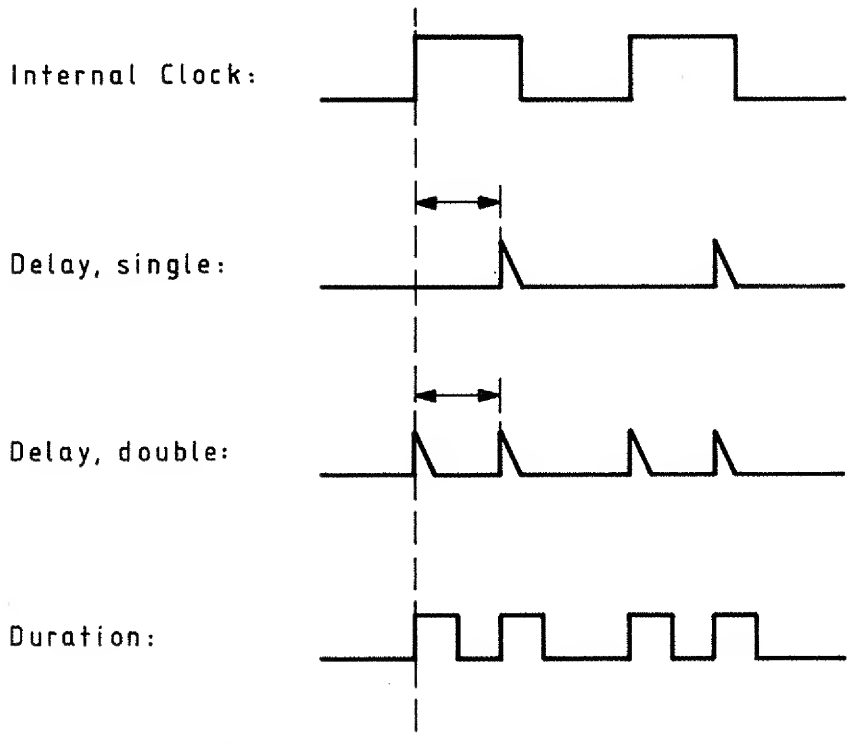
The attenuator divides the pulse amplitude to the 2.5, 1.0 and 0.4 V ranges. It is built on a separate printed circuit board mounted on Unit 4.

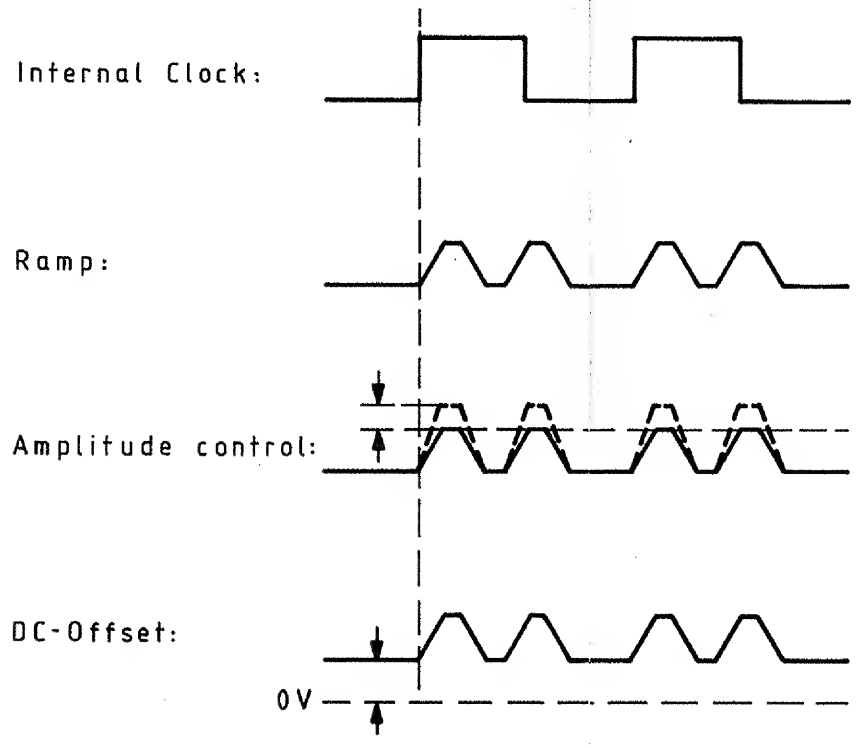
As a last step, the DC-Offset is added from current generators directly to the output terminals.

Block diagram



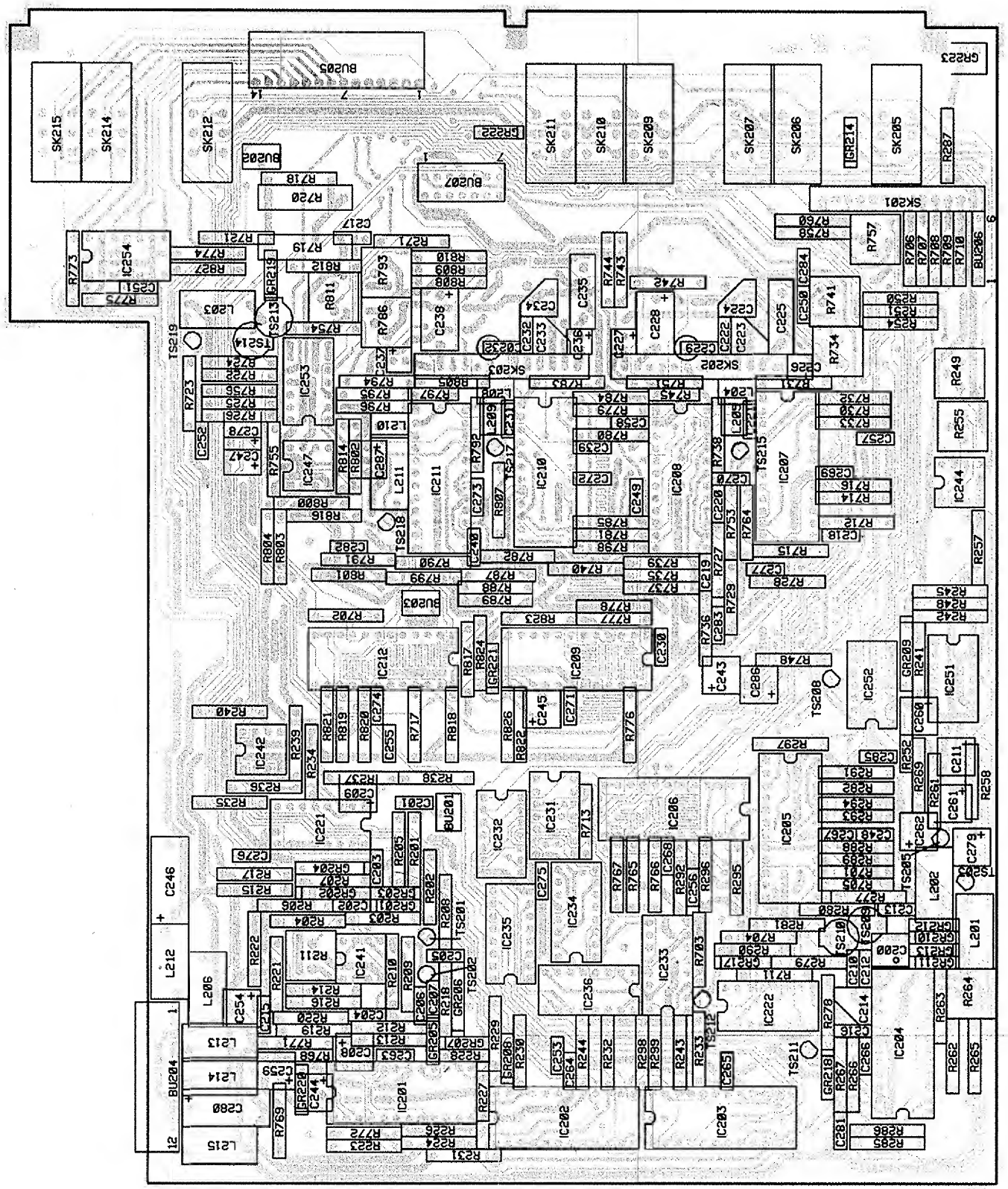
Waveforms in some blocks





TIMING BOARD, UNIT 2

Item	Pins	-17V	-5V	-2V	GND	+15V	NOTE
IC201 ... IC212	24		18		6, 7		
IC221	16		8		16		VCC1 to pin 1
IC222	16		8		1, 16		
IC231, IC232	14		7		14		
IC233 ... IC236	16		8		16		
IC241, IC247	8	4				7	
IC242	8			4		7	
IC244	8		4			7	
IC251	14				11	4	
IC252	14	11					+IC252 to pin 4
IC253	14	11			4		
IC254	14			11		4	



HOW TO READ THE DIAGRAMS

This chapter contains circuit diagrams and component layouts for PM 5786 and PM 5786B.

Each component layout has been completed with a list of the IC:s used in the unit. This list indicates the number of the pins on each IC and the connections that are not shown in the diagram, such as GND and supply voltages.

Format

Most diagrams in this manual are drawn within an X-Y matrix. The X-coordinates (horisontal) are designated A...S and the Y-coordinates 0...11 (vertical). Any position can therefore be located with a digit and a letter coordinate.

Circuit symbols

The diagrams are computer drawn. The symbols conform to IEC-standards. These symbols are designed to be logical and easy to read;

The component number is written above the symbol.

Inside the symbol, at the top is an abbreviated description of the circuit's function.

Pin numbers are written outside the symbol and, if it is a complex circuit, the pin functions are written inside.

A small circle on a pin indicates that the output/input inverts the signal.

The component name is written below the symbol.

The signal flow through a symbol is always from the left to the right.

Resistors, capacitors, diodes, transistors and other components.

These components are similar to the old-fashioned, hand-drawn, symbols;

They have their component number above and their value or component name below.

A resistor contained in a resistor network, has a frame drawn around it and one of the pin numbers is written to the left or below it.

Component numbers

"R610" is a typical component number. The "R" indicates that it is a resistor, "6" that it is positioned on the "Unit 6" and 10 that it is the tenth resistor in the component list for that unit. This is a pretty thought but, unfortunately it is not fully implemented.

Signals

Signals are named after what they do, e.g. RESET resets a counter. The function indicated by a signal name occurs when the signal is logically high.

If a signal line or a bus is to go a long distance, for instance to another sheet, it can be terminated with an arrow and X-Y coordinates. These coordinates give the position where the signal continues on the next sheet.

NOTE: Two different arrows are used to indicate that the connection is continued somewhere else on the circuit diagram:

▷ This arrow indicates a continuation on the same sheet.

▷ This arrow is used when the circuit diagram for a unit is divided onto two sheets and the connection continues on the other sheet, (only used on U1).

The code written on each arrow indicates where the connection continues. The first position in the code indicates the sheet number while the following two positions in the code gives the coordinates on the sheet.

Colored areas

Blue = Integrated circuit
Green = Trim-point or Test point
Yellow = Connector

Colored signal paths

Some signal paths are coloured to make it easier to understand the diagram. See the explanation of the color on each diagram.

CIRCUIT DESCRIPTIONS

Introduction

The diagrams supporting the descriptions in this chapter are simplified to help the reader understand the function of the circuits. Fold out the complete diagrams and use them together with these simplified versions.

Where the circuits for both output A and output B are similar, only the components for output A will be mentioned.

External Input

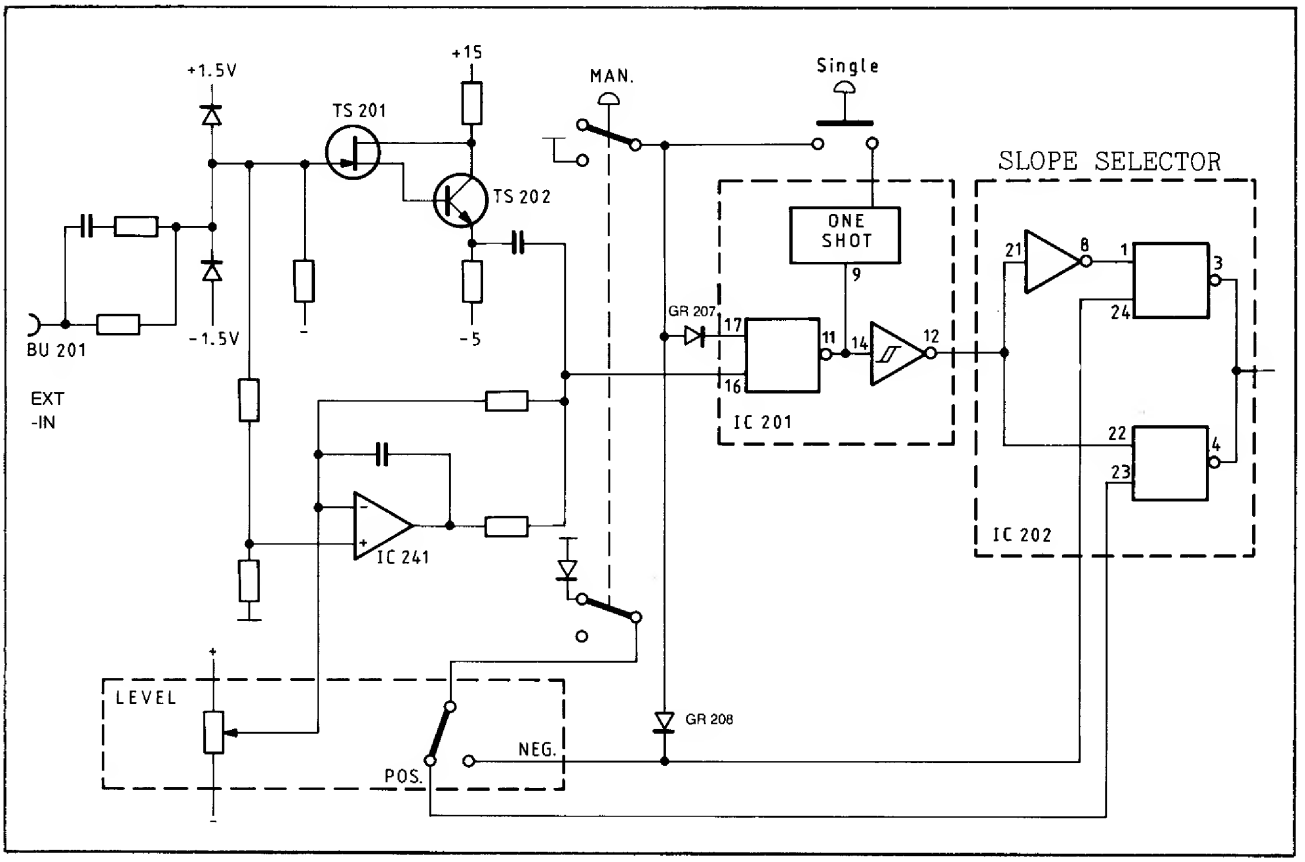
The external input is used to trigger the pulse generator in certain pulse modes.

The EXT IN connector is routed to an input amplifier consisting of an LF-part, IC241, and a HF-part, TS201 and TS202. The trigger level of IC241 can be set with the LEVEL potentiometer on the front panel. The output of TS202 is connected via C206 to the output of the LF-part. The clipping diode GR205 is connected to -1.5 V, generated by GR206/R218. This arrangement prevents the signal from going above -0.8 V, thus adapting the signal to ECL levels.

The signal is inverted by IC201:11 and again by IC201:12; it is then fed to the input of IC202:4+8. IC202:4+8+3 is the positive/negative slope selector. If the switch in the LEVEL potentiometer is in the negative position, IC202 pin 24 is high which makes IC202:3 block the signal. IC202 pin 23 is low so that the signal can pass through to IC202 pin 4. If positive slope is selected, IC202:3 opens and the signal passes through inverter IC202:8 and IC202:4.

If the MANual button is depressed, the high signal to the slope selector switch is removed. Instead GR208 pulls the NEG SLOPE signal high so that negative slope will always be selected.

IC201:10 selects whether the signal from EXT IN, or the signal from the SINGLE button should be used. If MANual is selected, SK207 pin 2 goes high (0 V), switching off the output of IC201:11. SK206 pin 3 goes high, which enables the SINGLE button to trigger the one-shot IC201:4+8. When the SINGLE button is depressed, the one-shot generates one, single, positive pulse that is free from contact-bounce.



⊥ =High
-5V=Low

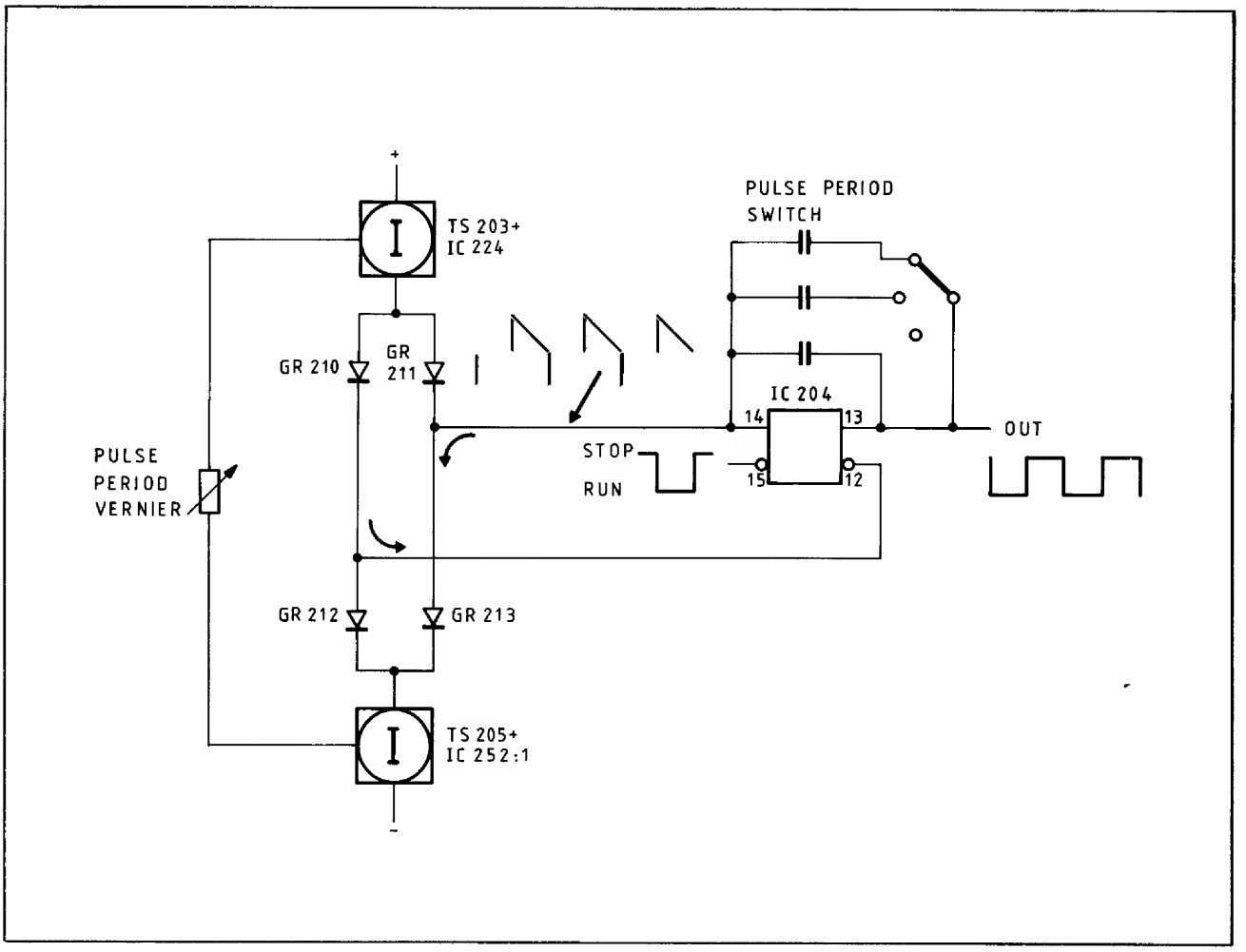
Clock Oscillator

The clock oscillator generates the signal used to trigger the generator when the INT CLOCK button is depressed. The oscillator can generate clock signals in three ranges: 8...20 ns, 20... 100 ns and 100 ns...1 µs.

The oscillator is built around an ECL line-receiver, IC204:13, two current generators, TS203 and TS205 and the three timing capacitors C212...C214.

When the oscillator is running, the timing capacitor is charged by TS203 via GR211. When the charge reaches the threshold level of the line-receiver, the line-receiver flips over and the timing capacitor starts discharging via GR213 to TS205. When discharged, the line-receiver flips again and the cycle is completed.

During that half cycle when a current generator does not charge (discharge) the timing capacitor, GR210 (GR212) opens and lets the current through to the inverting output of the line-receiver.

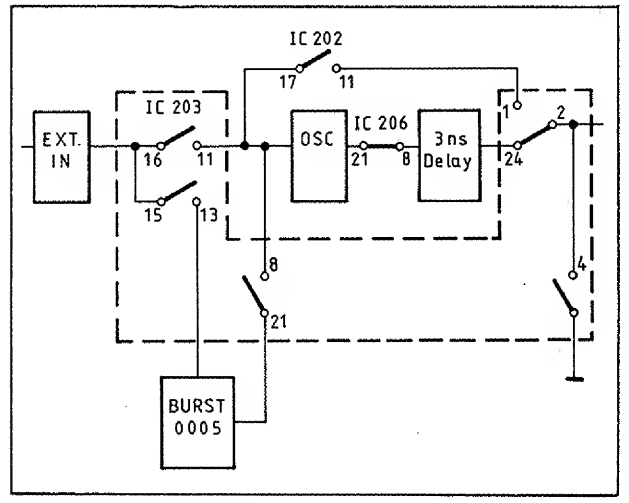


External control of the oscillator

It is necessary to start and stop the oscillator very precisely e.g. to be able to output a predetermined number of pulses in a burst.

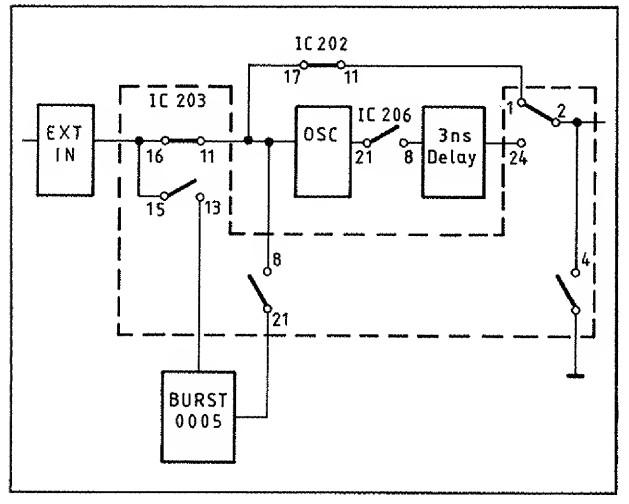
This is ensured by the start/stop circuit in the oscillator IC204:2 and the gates IC202:11, IC206:8 and IC203.

If the INT CLOCK button is depressed, gate IC203:11 disconnects the EXT IN signal from the oscillator. IC206:8 and IC203:24-2 conduct so that the oscillator signal is connected to the output.



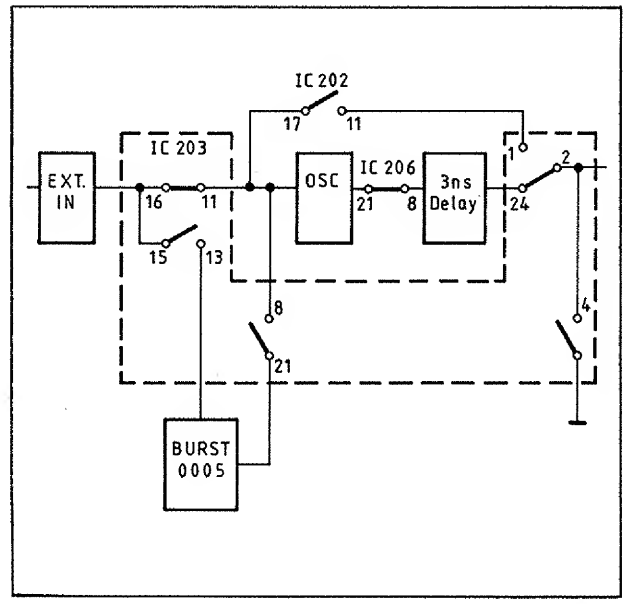
The oscillator will run continuously.

If the TRIGG button is depressed, IC202:11 conducts enabling the EXT IN signal to pass through to IC203:1. The oscillator is stopped by pulling IC204:1 to low via R286. IC206:8 disconnects the oscillator from the output.

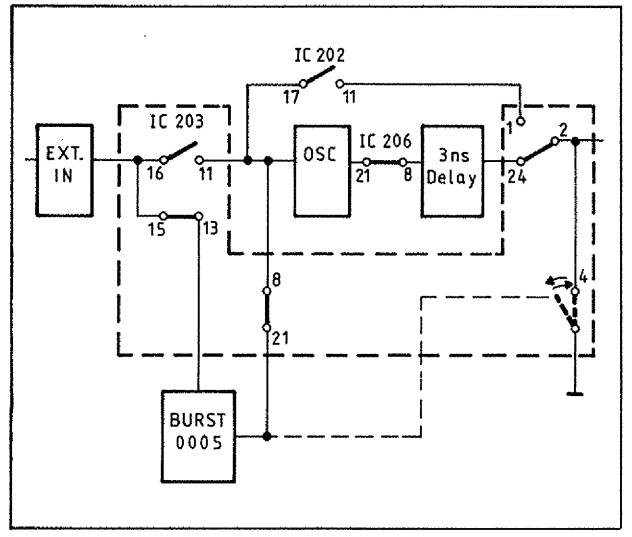


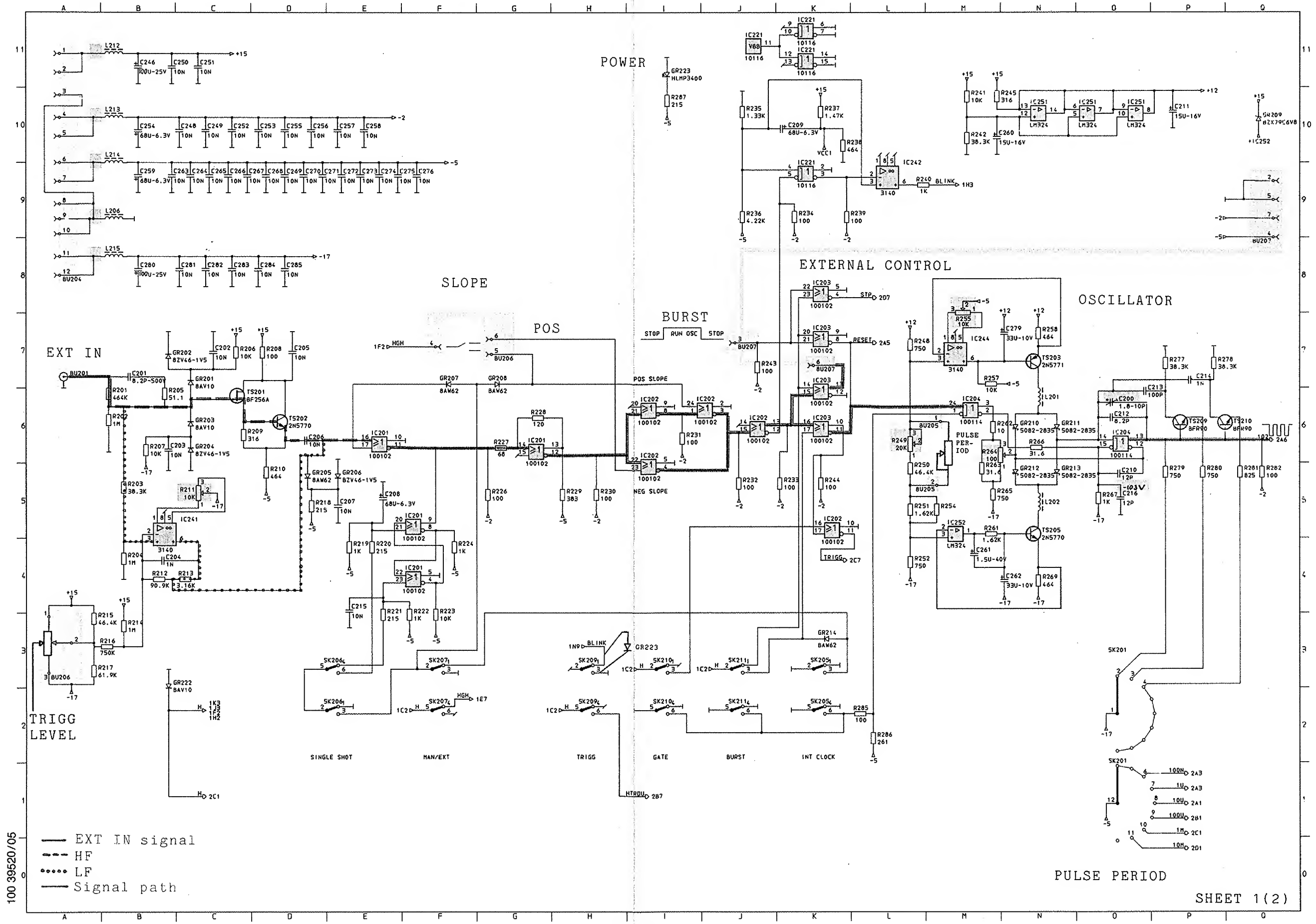
The EXT IN pulse directly triggers the delay and duration circuits placed after the oscillator.

If the GATE button is depressed, the EXT IN signal will be connected via IC203:11 as START/STOP signal to the oscillator. IC206:8 and IC203:24-2 conduct so that the oscillator signal is connected to the output.



If the BURST button is depressed, gate IC203:11 disconnects the EXT IN signal from the oscillator. IC203:13 conducts so that the EXT IN signal will pass to the burst counter. The output of the burst counter goes to IC203:8 and IC203:4. When the output of IC203:8 goes low, the oscillator starts. When the burst counter has counted to the preset number, IC203:8 goes high, which stops the oscillator and resets the oscillator decade counters. To prevent the oscillator from producing extra cycles, the signal is delayed 3 ns in the delay line. This delay makes it possible for the signal from IC203:4 to pull the output of the oscillator high before a new cycle is started.





Clock frequency divider

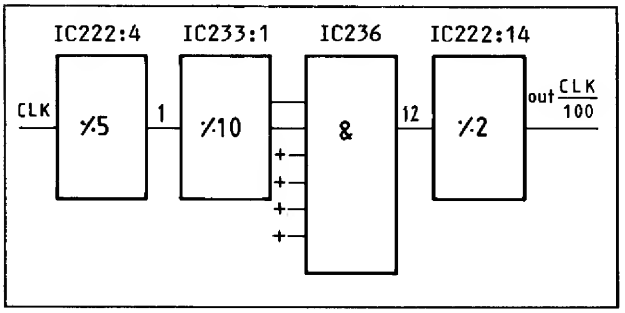
The PULSE PERIOD switch can be set to nine ranges, but the oscillator only generates the three fastest. The other ranges between one microsecond and one second are produced by dividing the frequency of the 100 ns...1 µs range by 10, 100, 1000, 10000, 100000 or 1000000.

The divider chain consists of one ECL decade counter and five TTL decade counters. The position of the PULSE PERIOD switch decides how many counters should be used. The outputs of the TTL counters are connected to a NAND gate, IC236, so when all counter outputs are high, the output of the NAND gate goes low. TTL counters out of use are set to nine (both outputs high) by the PULSE PERIOD switch.

When the PULSE PERIOD switch is set to one of the three fastest ranges, IC205:22 is open and the oscillator signal bypasses the counters.

When 1 µs...100 µs is selected, IC205:22 is closed and IC205:8 and IC206:1 are open instead. Now the output signal is taken from the ECL divider. Since all TTL counters are set to nine, the output of IC236 will go low directly and only the ECL counter will work. The oscillator frequency is first divided by five, then by two.

When the PULSE PERIOD switch is set to 1 µs... 10 µs, the left-hand TTL counter (IC233:1) will be activated. IC222:4 divides the oscillator frequency by five.

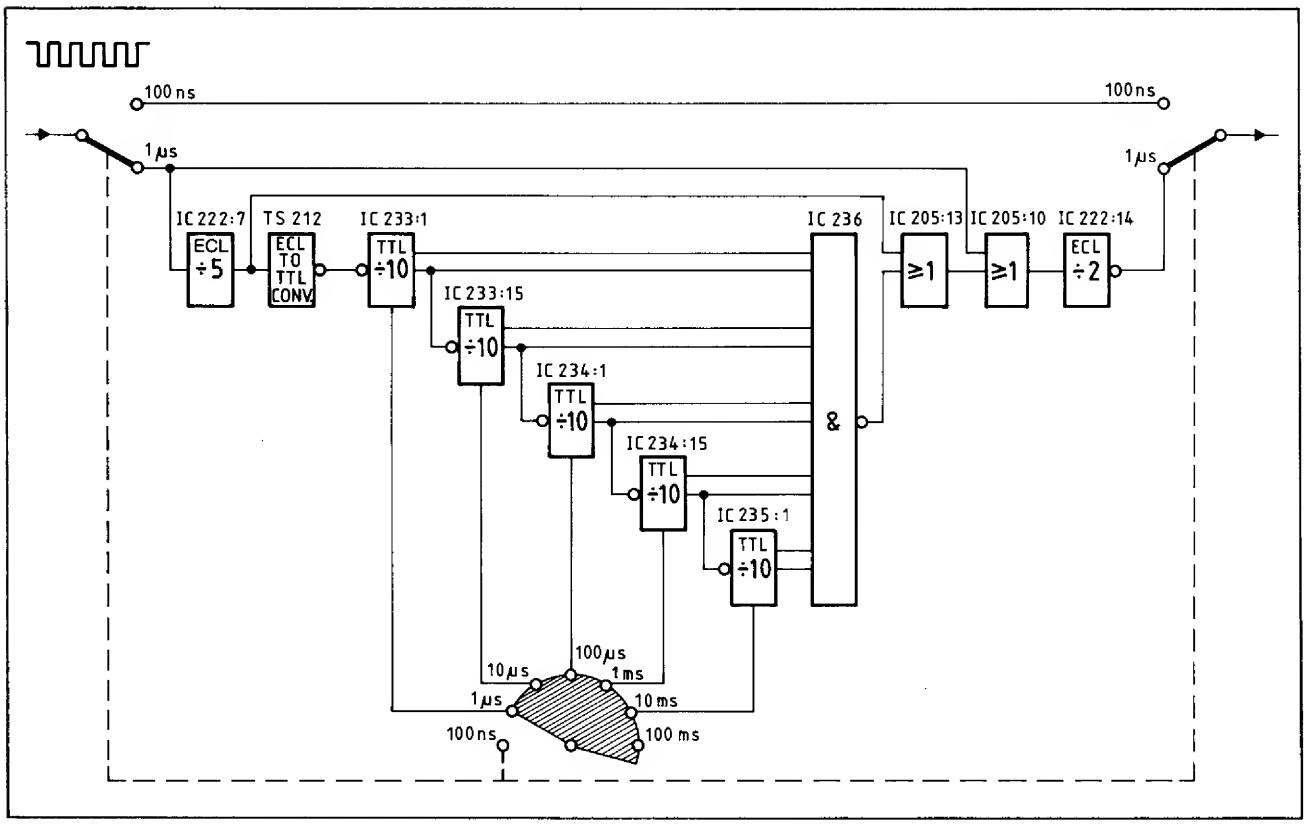


This signal will be fed to IC233:1. It will count to nine, then the output of IC236 will go low and trigger the 'divide by two' counter IC222:14.

This cycle will be repeated once more (50 clock cycles), until the output of the IC222:14 changes status and the division by 100 is completed.

Division by other factors is performed in a similar way.

IC205:10 and 13 make sure that the status change is made on a positive edge of the clock signal.

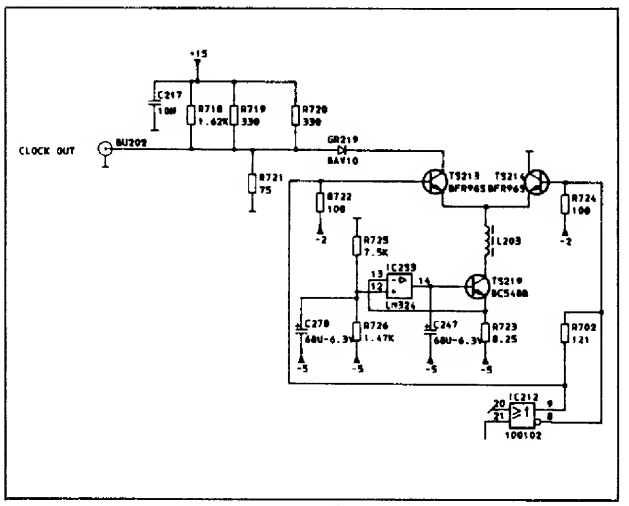


Clock Output

The output signal from the clock oscillator or frequency divider feeds the clock-out amplifier via C207:13. The signal is split into one inverted and one non-inverted signal by IC212:8 which feeds a differential pair, TS214 + TS213. Only one transistor conducts at a time.

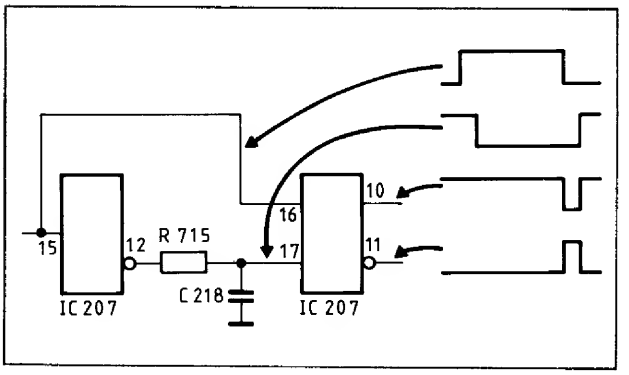
The emitters of these transistors are connected to a current generator TS219/IC253:14 which supplies 100 mA.

The collector of TS213 is routed to the CLOCK OUT connector via GR219.



Pulse delay

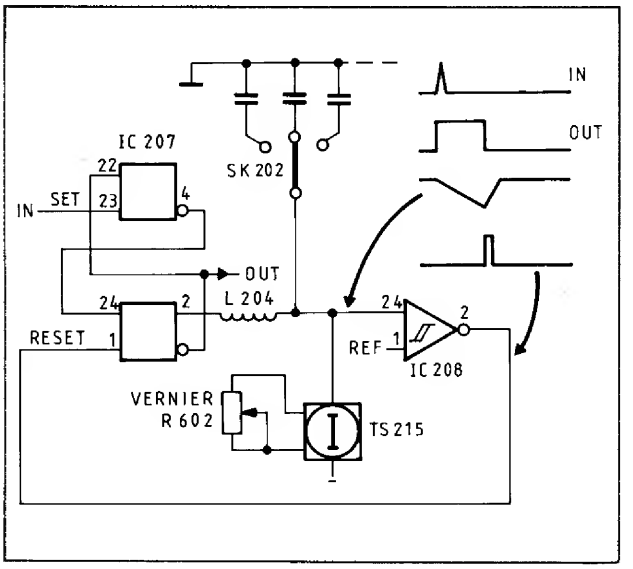
The purpose of the pulse delay circuit is to delay the output A and B pulses with respect to the CLOCK OUT pulse.



The oscillator output is fed to a gate, IC207:15. A delay network, R715+C218, is connected to the output of the gate. Both the delayed pulse and the original pulse are fed to IC207:11 the output of which is a very short pulse with a duration equal to the gate delay plus the delay in the RC network, i.e. approx. 3 ns.

When the 'EXT DUR or ⊓⊔ ' button is depressed the signal SDEL (Stop DELay) switches off the short pulses. Signal SYMH opens the gate IC212:4 so that the signal bypasses the pulse delay and pulse duration circuits and goes directly to the transition time board.

When the ⊓⊔ or the ⊓⊔⊓ button is depressed, the short pulse proceeds to the pulse delay circuit.



This circuit consists of a bistable flip-flop with one Set and one Reset input, a current generator which can charge a capacitor, and a Schmitt-trigger that compares the voltage over the capacitor with a reference voltage.

Before any trigger pulse has arrived, the flip-flop is reset so that IC207 pin 2 is high and feeds the current generator TS215. There is only a low voltage across the capacitor.

When a short positive pulse arrives, it makes the flip-flop, IC207:4+3, toggle. Now the IC207 pin 2 goes low (floating), stopping the current flow through L204. The current generator TS215 starts charging the delay timing capacitor, C222 to C228.

When the capacitor is charged to the threshold level of the Schmitt-trigger, IC208:24, the output of the Schmitt-trigger resets the flip-flop. Now the capacitor is discharged rapidly by the current from IC207 pin 2, and the cycle is completed.

The value of the capacitor, thus the delay time, can be selected by the PULSE DELAY switch SK202.

Pulse duration

The purpose of the pulse duration circuit is to generate a presettable pulse duration. The function principle of this circuit is the same as for the pulse delay circuit, except for IC210:10 which is inserted to prevent oscillation.

The value of the duration time capacitor, thus the duration time, can be selected by the PULSE DURATION switch, SK203.

The PULSE DURATION vernier is connected to IC253 pin 2. This IC controls transistor TS217 which is the current generator that determines the charge time of the duration timing capacitor.

The output of the pulse delay circuit is fed to a short-pulse generator, IC209:4+3, exactly as in the pulse delay circuit. The short-pulse is generated on the trailing edge of the delay pulse.

The short-pulse triggers the pulse duration circuit and makes the flip-flop, IC210:12+3, toggle. Now the IC210 pin 2 goes low (floating), stopping the current flow through L208. The current generator TS217 starts charging the duration timing capacitor, C232 to C238, with a negative voltage. When the capacitor is discharged to the threshold level of the Schmitt-trigger, IC211:24, the output of the Schmitt-trigger resets the flip-flop. Now the capacitor is charged again rapidly by the current from IC210 pin 2.

The generator must be able to generate waveforms with durations as short as 3.5 ns, but this is not possible with only the circuit above, due to the delay of the signal in the gates.

This is solved by using a separate signal path for the signal that generates the trailing edge. In this path, the 'trailing' signal must pass fewer gates than the 'leading' signal from the flip-flop.

So in addition to the current-generator charging the duration timing capacitor, the PULSE DURATION vernier controls current generator TS218. If the vernier is set to maximum, only a small current flows to TS218, making the input signal to IC210 pin 21 very slow. In this case the flip-flop generates both the leading and the trailing edge of the duration pulse.

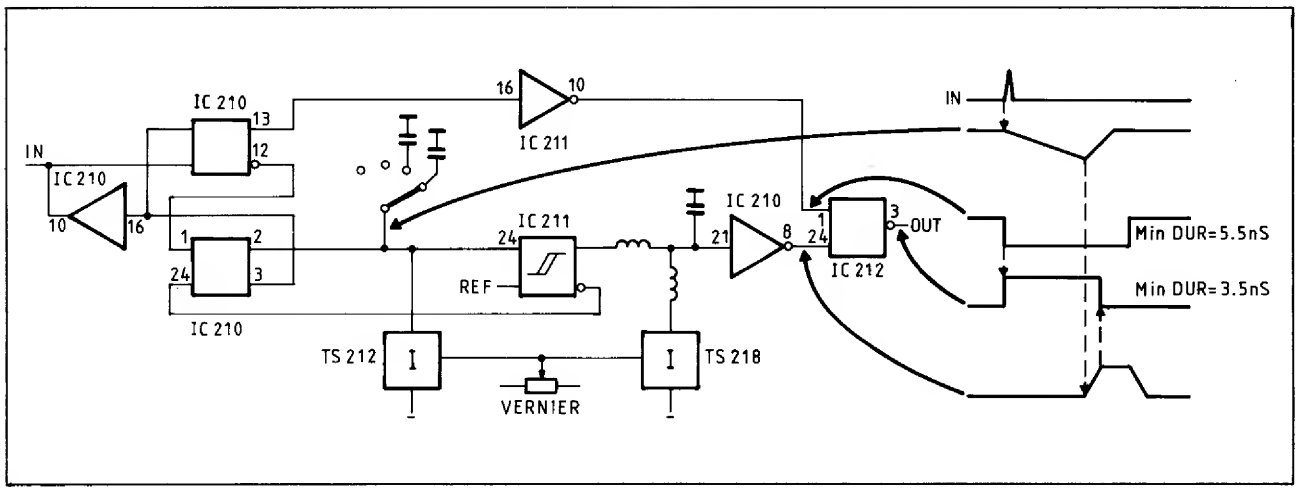
On the other hand, if the vernier is set to minimum, a high current will flow, making the signal to IC210 pin 21 so fast that it shuts off IC212:3 at the same time the flip-flop is reset. In this case the leading edge is generated by triggering the flip-flop and the trailing edge is generated by shutting off the output.

Double pulse

The short-pulse is fed to IC210 pin 23. When the ⎍ button is depressed, the other input, pin 22 is low so that the pulse can pass.

However when the ⎍⎍ button is depressed, pin 22 receives a short pulse from the circuit in front of the pulse delay circuit.

So, both the input pulse to the delay circuit and the delayed output signal from the delay circuit trigger the pulse duration circuits. The output will be a double pulse with the set pulse delay as the spacing between the pulses.

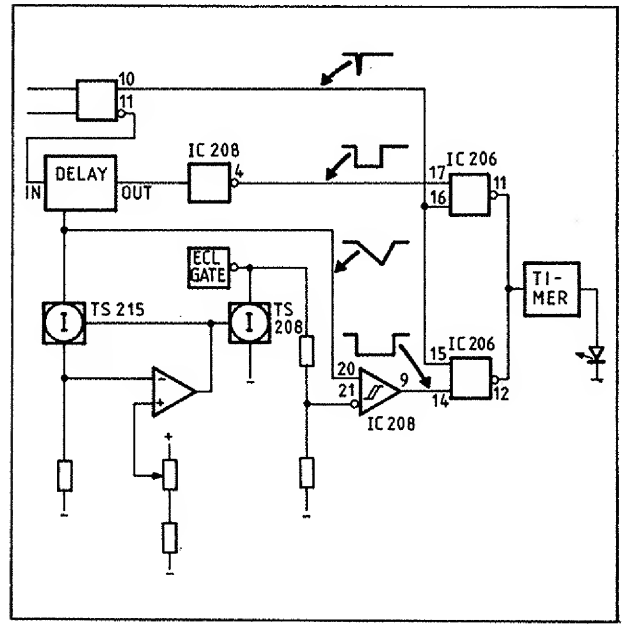


Error indicators for Pulse Delay and Duration

Both the error indicators are built in the same way so only the pulse delay error indicator will be described. See the diagram for the component numbers for the pulse duration error indicator.

The error detector has two functions: It detects if any new pulse arrives when the pulse delay circuit is already generating a pulse and, it detects if any new pulse arrives during the discharge time of the delay timing capacitor.

The output pulse from the delay circuit is inverted by IC208:4 and then fed to gate IC206 pin 17. The delay circuit input signal is connected to the other input of the gate, pin 16. The gate compares the signals and if a new pulse arrives on the input while pin 17 is low, the gate output will go high, triggering the timer circuit, IC 201:2.



IC208:9 is a circuit which detects the discharge time of the delay timing capacitor. It is a Schmitt trigger that works as a comparator. It compares the ramp-voltage at the delay timing capacitor with a reference voltage. The threshold level of the comparator is very close to the high state of IC207:2 so, the output of the Schmitt trigger will be low from the time that the charging starts until the discharging of the delay timing capacitor is completed.

The output pulse from the Schmitt trigger is fed to gate IC206 pin 14. The delay circuit input signal is connected to the other input of the gate, pin 15.

The gate compares the signals and if a new pulse arrives on the input while pin 14 is low, the gate output will go high, triggering the timer circuit, IC 201:2.

When the timer receives a short pulse on pin 24, it generates a pulse long enough for the eye to see.

Reference voltage for the recharge time sensor - Delay

The output voltage level of IC207:2, when high, varies with the setting of the PULSE DELAY vernier. A shorter delay means higher current and lower output level.

Since the Schmitt trigger threshold level should be very close to the 'high' level of IC207:2, the threshold level must also vary with the setting of the vernier.

The PULSE DELAY vernier controls an operational amplifier, IC252 pin 12. The output of the op-amp is connected to two transistors that work as current generators (TS208 and TS215). Both current generators will produce equal currents.

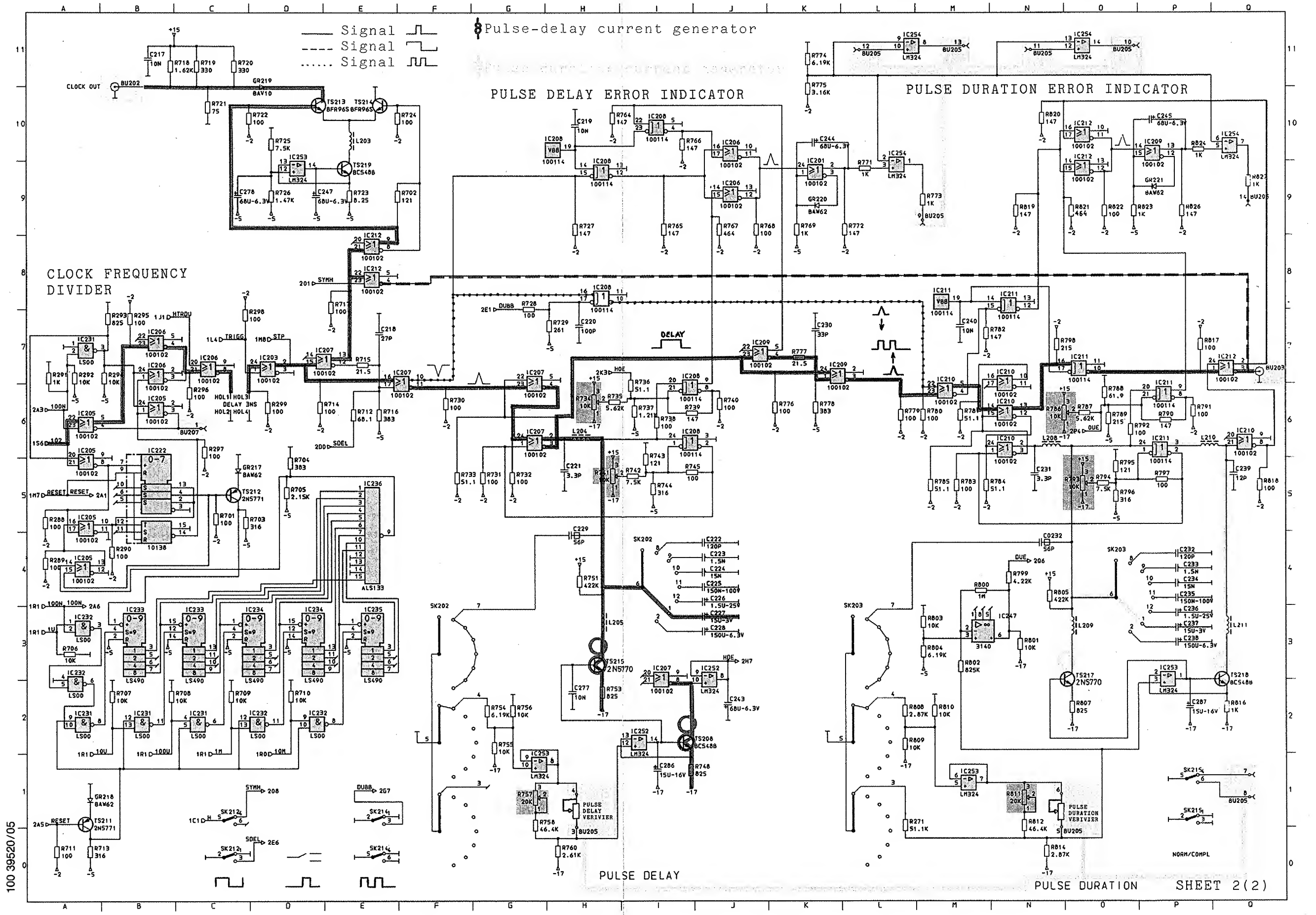
TS215 is the current generator that is connected to IC207:2 and the the delay timing capacitor. TS208 is connected to IC207:8 which is an ECL gate with open inputs. This makes the inverting output of the gate high.

When the vernier that controls both current generators is set for a larger current (shorter delay), the voltage at TS207:8 will drop by approximately the same amount as that on the output of IC207:2, so this voltage is buffered by IC252:8 and used as reference voltage for the Schmitt trigger IC208:8.

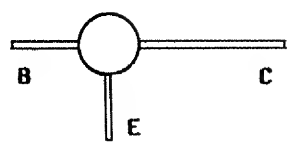
Reference voltage for the recharge time sensor - Duration

The problem is the same as for the delay circuit but the solution is somewhat different:

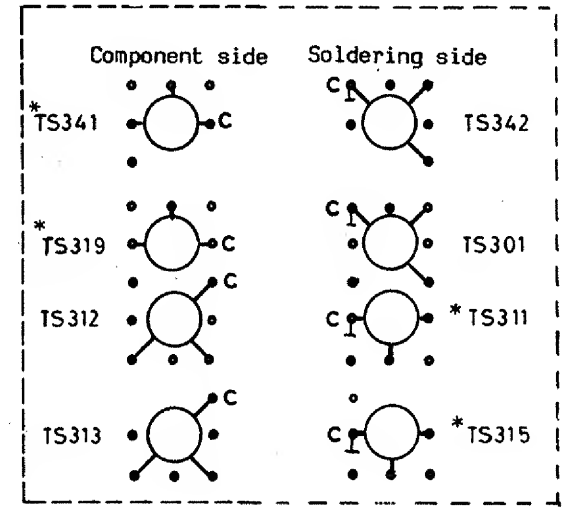
IC247:6 generates a voltage that is an approximation of the output voltage drop of an ECL-gate. When the vernier is set for a larger current (shorter duration), the output voltage will drop by approximately the same amount as that on the output of IC210:2.



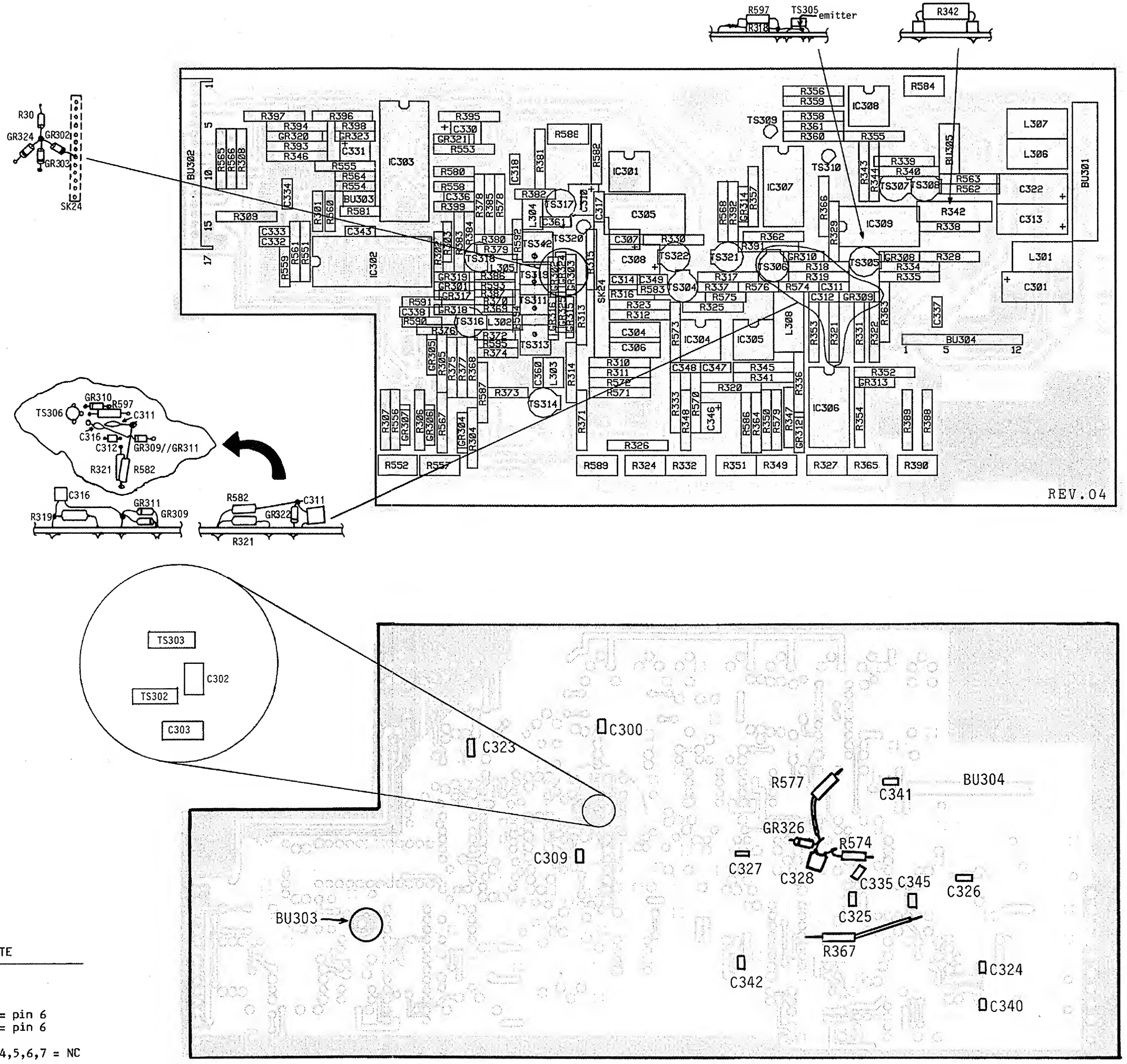
TRANSITION TIME BOARD, UNIT 3 Rev. 4 *



Some of the transition generating transistors are mounted upside down, the figure shows the pinconfiguration of a transistor with the text facing the observer.



Component layout for transition generating transistors. Transistors marked with * are mounted upside down.



Item	Pins	-17 V	-5 V	GND	+8 V	+15 V	NOTE
IC301	8	4		7			
IC302, IC303	24		18	6, 7			
IC304, IC305	8	4				7	
IC306	16				16		pin 7,8 = pin 6
IC307	16			16			pin 7,8 = pin 6
IC308	8		4			7	
IC309	16	16					pin 2,3,4,5,6,7 = NC

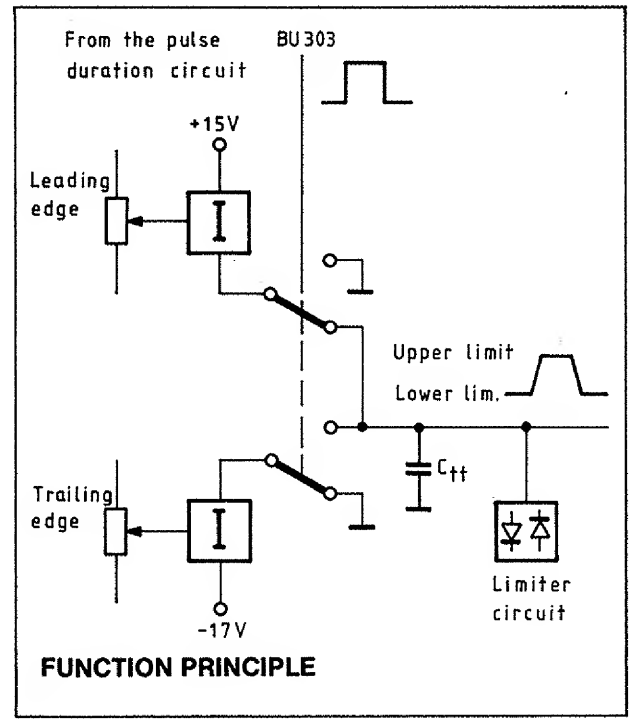
*See the end of this chapter for later revision

Ramp generator

Function principle

The ramp generator adds continuously variable rise- and fall-times to the pulse from the pulse duration circuit.

The input pulse switches in and out current generators, charging and discharging capacitor C_{tt} ($=C_{transition-time}$) to levels set by limiter circuits. A high charging or discharging current gives a fast edge and a low current gives a slow edge.



FUNCTION PRINCIPLE

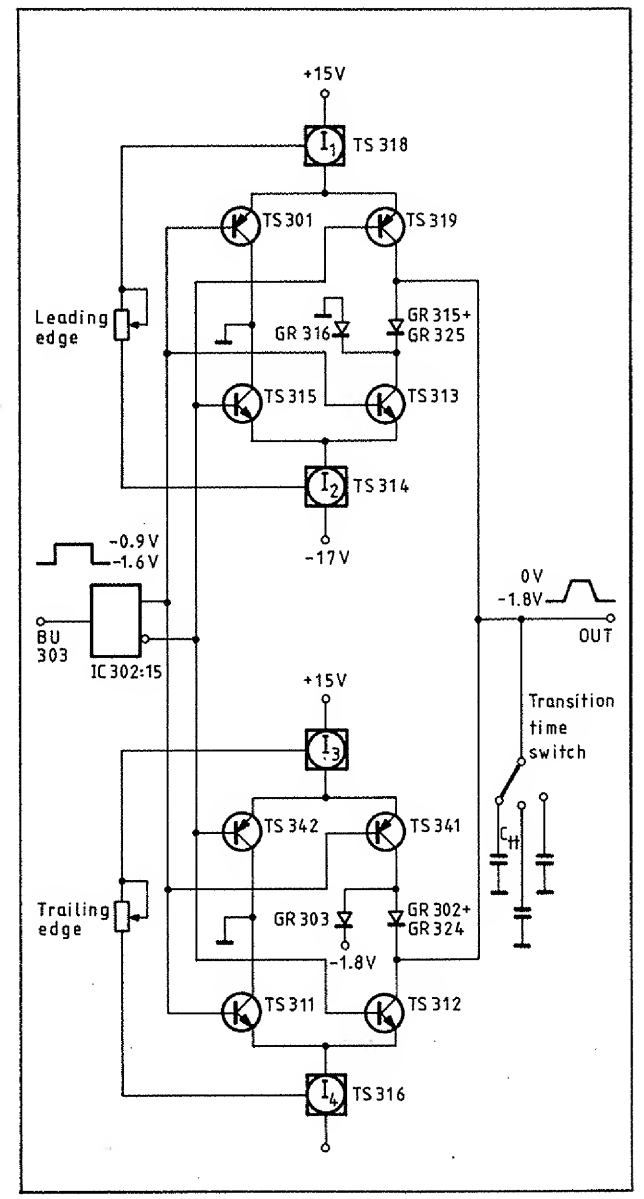
Function description

The ramp generator consists of four current generators, TS318, TS316 for the ramps and TS317, TS314 for the limiter. It also contains eight current switching transistors that switch the generators between the load (when active) and ground (when idling).

The eight current switches are driven in push-pull from the ECL-gate IC302:15 via four zener diodes (not shown here).

The ramp voltage is limited to 0 V by the diodes GR315, GR325 and -1.8 V by GR302, GR324. GR316 and GR303 compensate for the forward voltage drop of the other diodes. The -1.8 V is set by potentiometer R390, via IC301 and TS320 (not shown here).

When the input BU303 is high, a positive slope is generated. TS319 is conducting so that the current generator TS318 can charge C_{tt}. TS313 is also conducting, pulling a current from ground via GR316 to the current generator TS314. The voltage over C_{tt} increases until it reaches 0 V, then GR315 + GR325 start conducting making the current from TS318 feed TS314 instead of charging C_{tt}.



When the voltage at BU303 goes low, TS319, TS313 are switched off and TS312, TS341 are switched on instead. Current is fed from C_{tt} to TS316, via TS312. TS341 is also conducting feeding the current from TS317 to -1.8 V via GR303. C_{tt} is discharged until the voltage across it reaches -1.8 V, then GR302 + GR324 start conducting making the current from TS341 feed TS312, thus ending the discharge.

Error detector for Leading and Trailing edge

The error detector switches on the front-panel LED-indicators when the pulse-edges are so slow that the amplitude of the output signal decreases to less than 50 %.

The input signal of the ramp generator is also fed to two line drivers in the error detector, IC302:24 and IC302:23. The signal to the trailing error detector is inverted first.

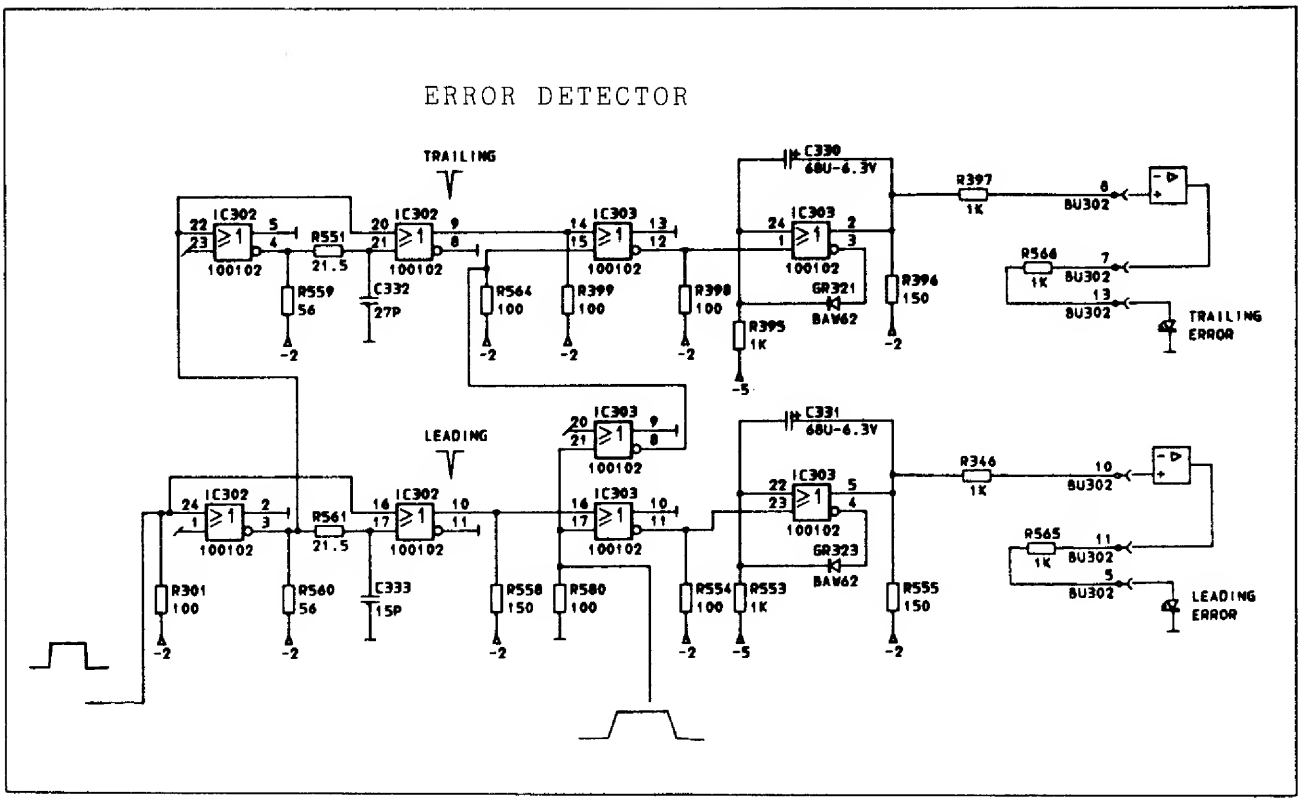
From here on the error detectors are identical so only the leading one will be mentioned.

The inverting output of the line driver IC302:3 is connected to a R-C filter R561-C333, which delays the signal. Both the original signal and the delayed signal are fed to another line driver, IC302:16, which produces a short pulse for each trailing edge.

NOTE: The short pulse for the leading error indicator is generated when the trailing edge starts, and vice versa!

This pulse is fed to one of the inputs of the next line driver, IC303:16. The ramp generator output signal is fed to the other input. If the output signal reaches the threshold level of the line driver (50 % of max amplitude) before the short pulse is generated, the short pulse will be blocked by IC303:16. Otherwise it will proceed to the timer IC303:23, which makes the LED-indicator blink.

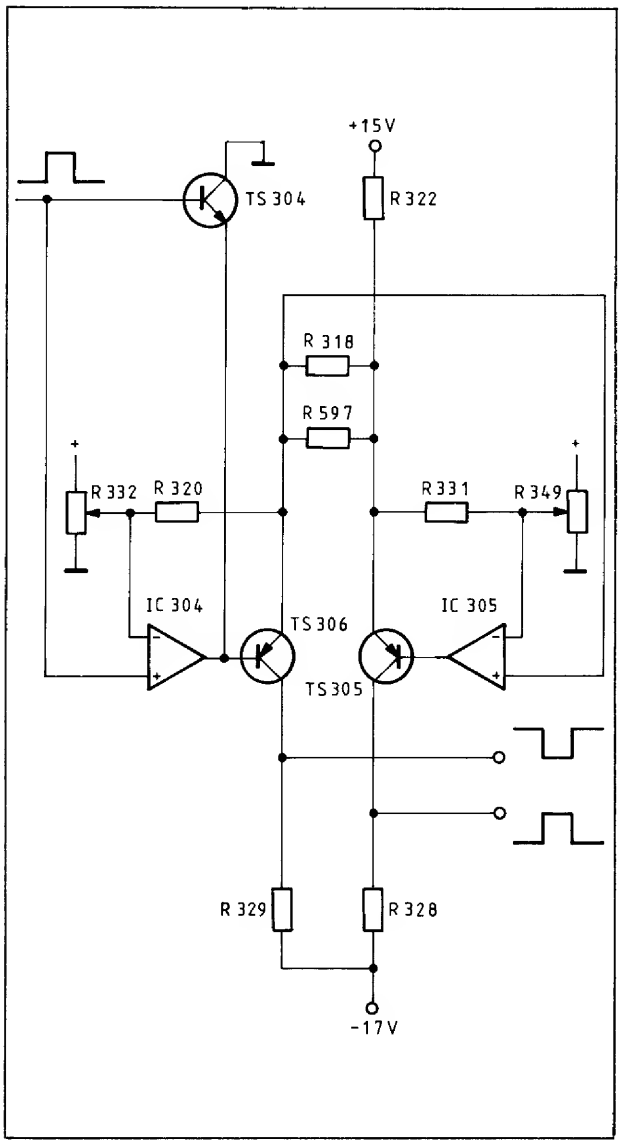
If the timer is triggered with a frequency above 25...30 Hz, the LED will light continuously.



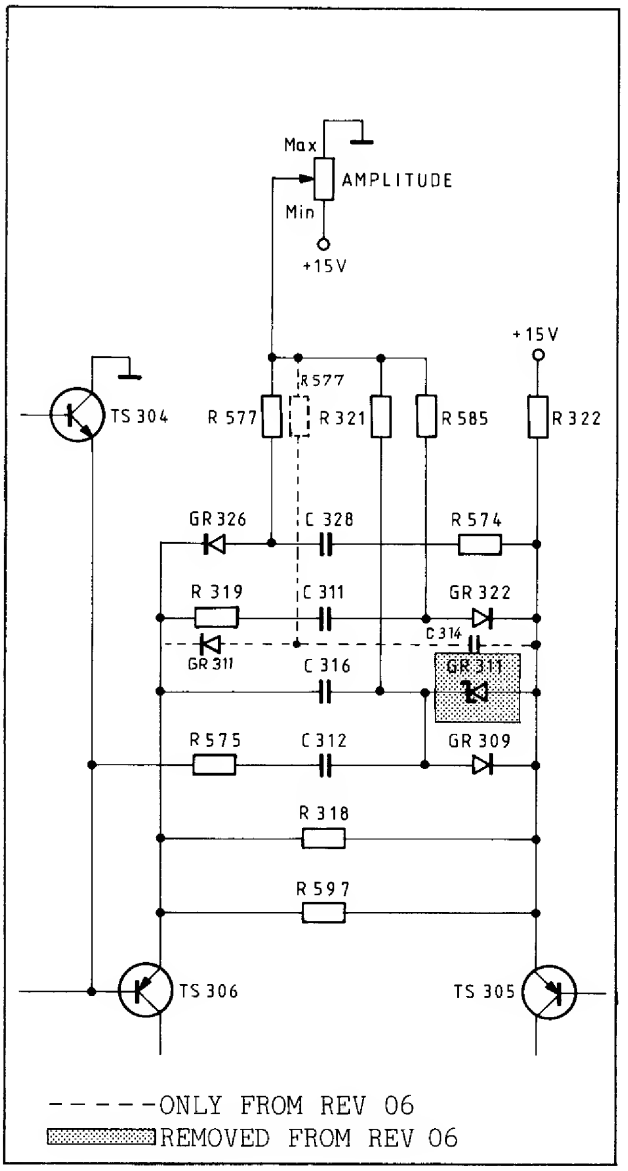
Differential amplifier with compensation network

A differential amplifier built around TS305 and TS306 divides the signal from TS304 into two complementary signals.

The amplifiers IC304 and IC305 set the quiescent current through the transistors and compensate for temperature drift.



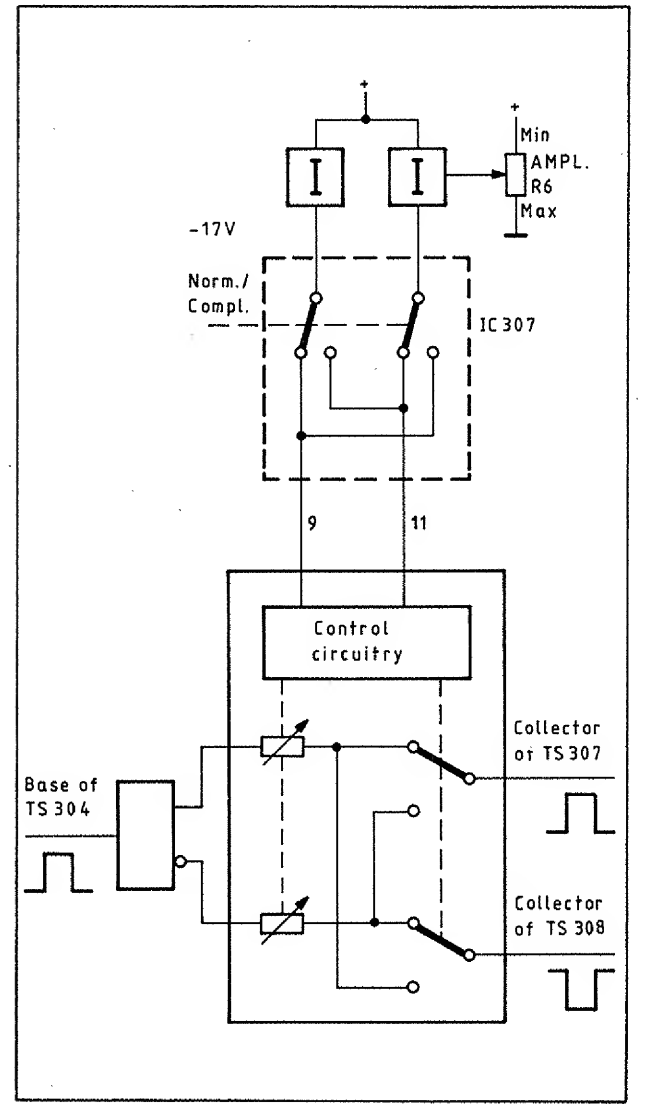
In order to compensate for non-linearity in the amplitude control circuit IC309, the differential amplifier incorporates different frequency compensation networks. GR326-C328-R574 and R319-C311-GR322 for low frequencies plus C316-GR311-GR309 and R575-C312 for high frequencies.



These compensation networks are connected to the amplitude control on the front panel in such a way that the current through the networks increases when the amplitude decreases. This speeds up the circuit for low amplitude settings.

Amplitude control

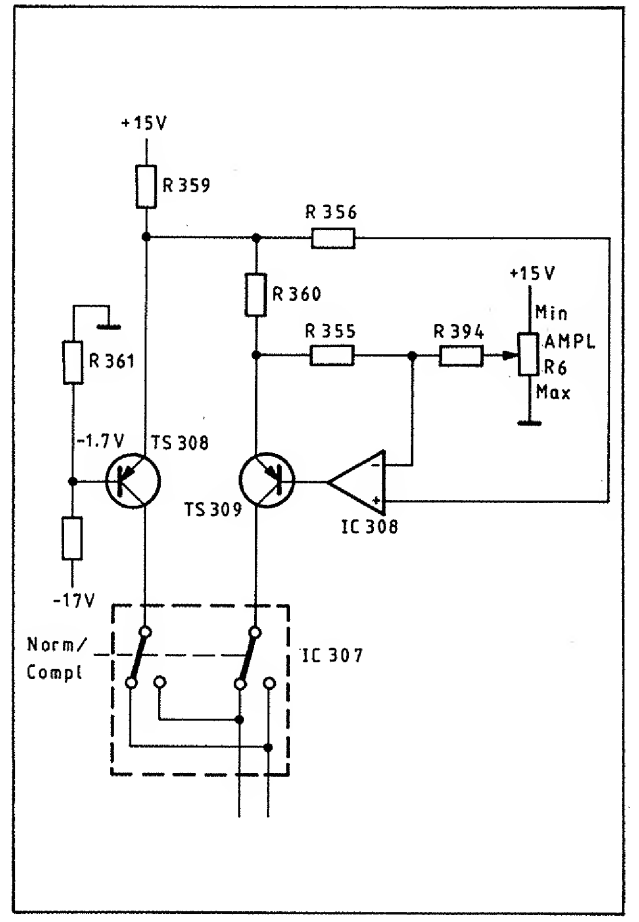
The purpose of the amplitude control circuits is to provide continuously-variable amplitude setting via the AMPLITUDE potentiometer on the front-panel. In addition to that function it also performs the Normal/Complementary switching.



NOTE: All functions between the base of TS304 and the collectors of TS307 & TS308 are current-controlled. This means that it is impossible to see the signal with an oscilloscope; all you will see are fixed DC-levels.

Current generators

Two current generators, connected as a differential pair, are used to control the amplitude control multiplier circuit IC309. The output current can be adjusted with the AMPLITUDE potentiometer R6 on the current generator built around TS310 + IC308. The other current generator built around TS309 has a fixed voltage on the base and uses the same emitter resistor as TS308, thus lowering its output current when TS308 increases its output current and vice versa.

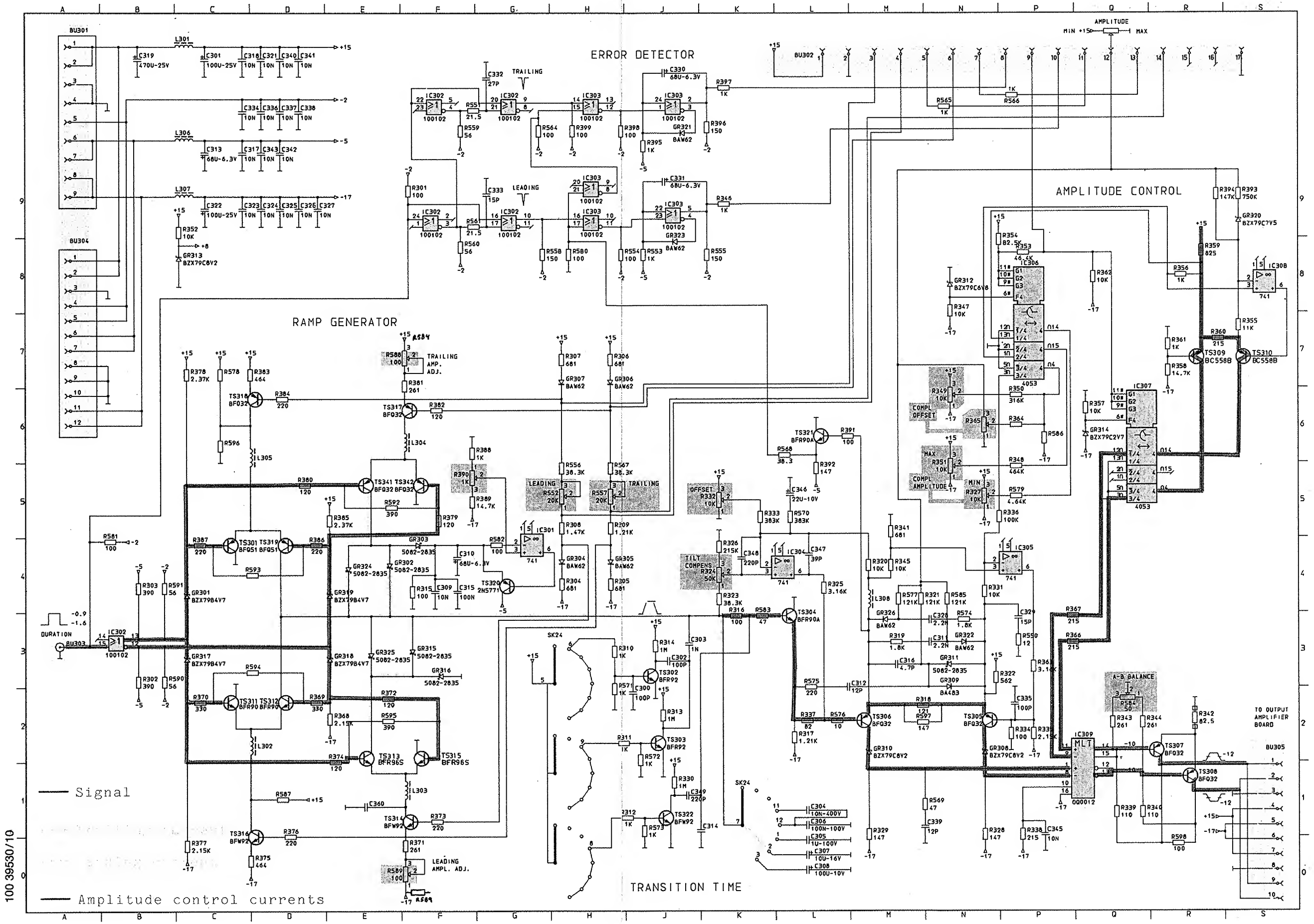


Control lines

The two currents are fed to IC309 pin 9 and 11. When the NORM/COMPL switch is set to NORM, the current in pin 11 is larger than the current in pin 9. When the switch is set to COMPL. the analog switch IC307 interchanges the currents.

Complementary adjustments

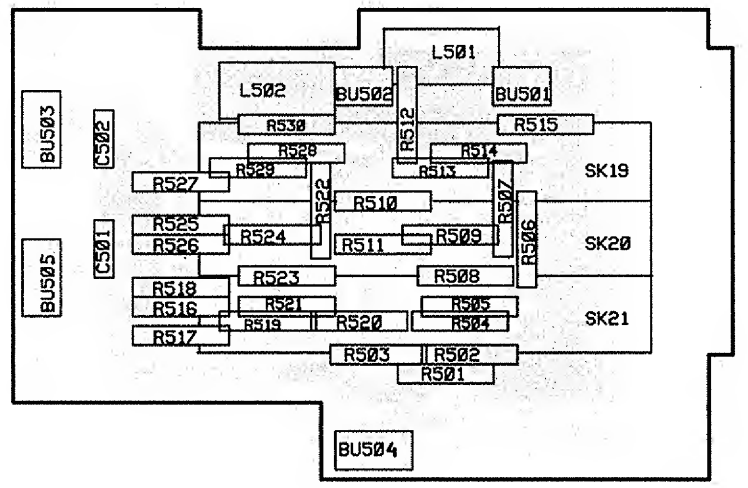
When set to complementary output, trimmers are connected to the current generators by IC306, so that it is possible to adjust the amplitude of the complementary pulses to equal the amplitude of the normal pulses.

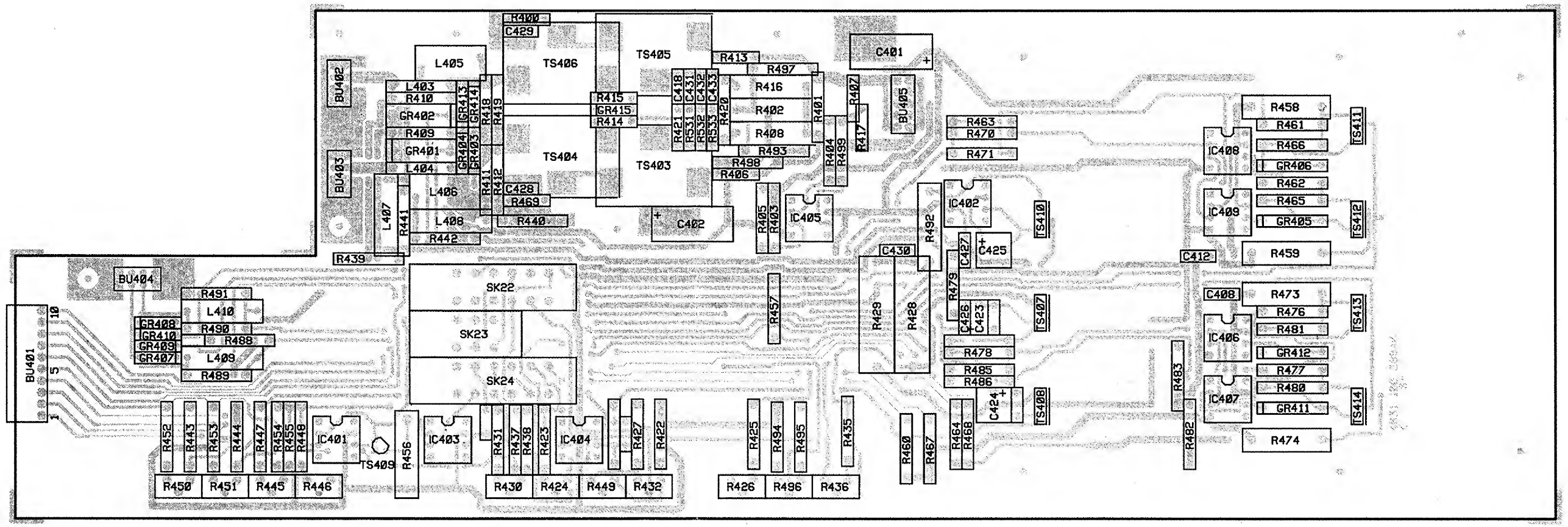


OUTPUT AMPLIFIER BOARD, UNIT 4

ATTENUATOR BOARD, UNIT 5

Item	Pins	-17V	GND	+15V
IC401 ... IC404	8		4	7
IC405 ... IC409	8	4		7



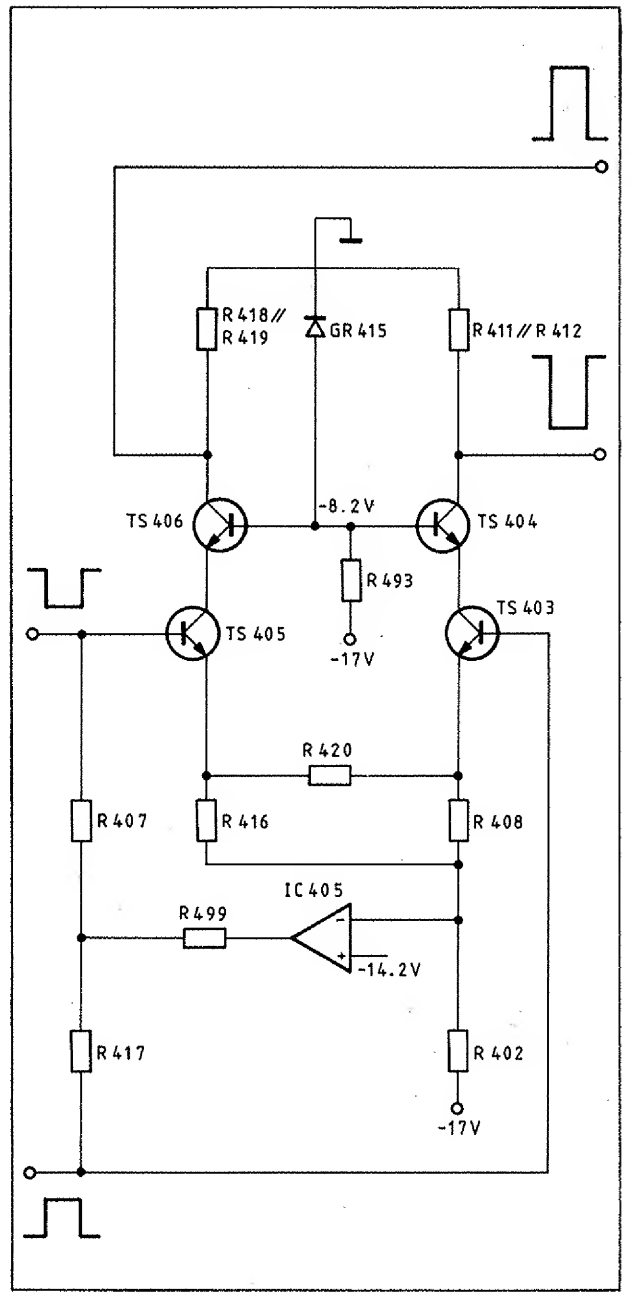


Output amplifier

The output amplifier for output A consists of TS405 and TS406 connected as a class A amplifier. Transistors TS403 and TS404 form the amplifier for output B. The two amplifiers are connected together as a differential amplifier by R420, a resistor for negative-feedback.

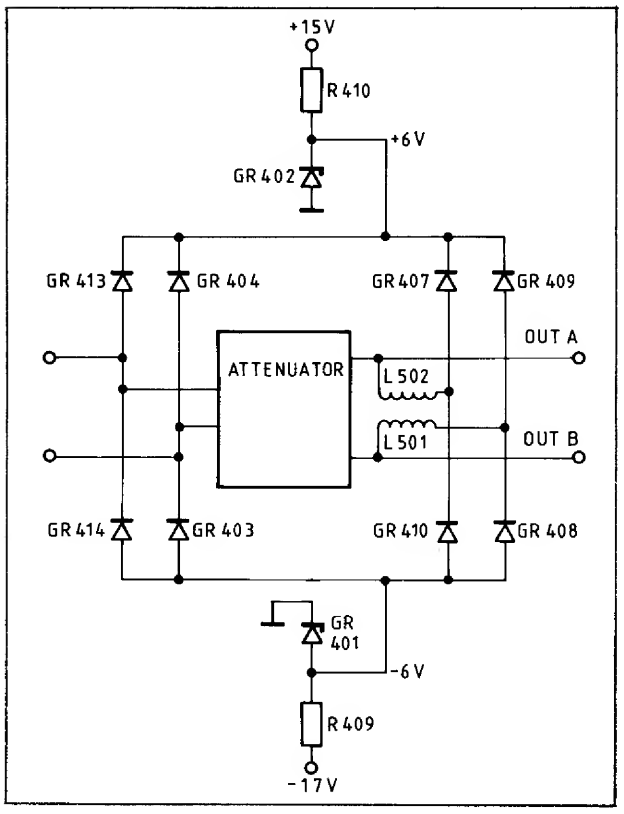
The A and B amplifiers have a common-emitter resistor R402. The voltage drop over this resistor is sensed by IC405. The output of IC405 adjusts the d.c. level on the input of the amplifiers so that the current through R402 stays at 280 mA. This compensates for temperature drift in the output transistors.

The power dissipation is divided between the two transistors in each amplifier. The base of TS406 is at a constant voltage (-8.2 V) set by zener diode GR415. The emitter of TS406 will then be at about -8.8 V. When the current to the base of TS405 increases, the current through the transistors will increase. As a result, the voltage drop over the collector resistor increases and so the output voltage decreases.



Protection of the outputs

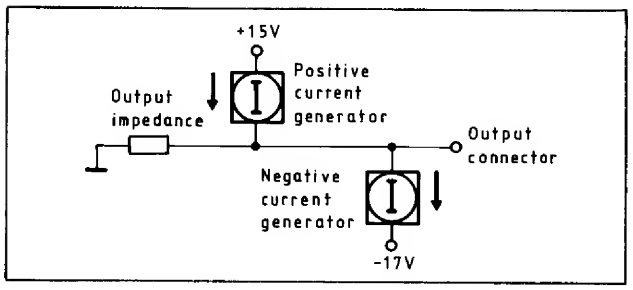
The collector of TS406 is connected via diode GR413 to +6 V and via GR414 to -6 V. These diodes limit the output swing to ±6 V. They will also limit the amplitude of any external signal applied to the output connector to avoid damage to the output transistors.



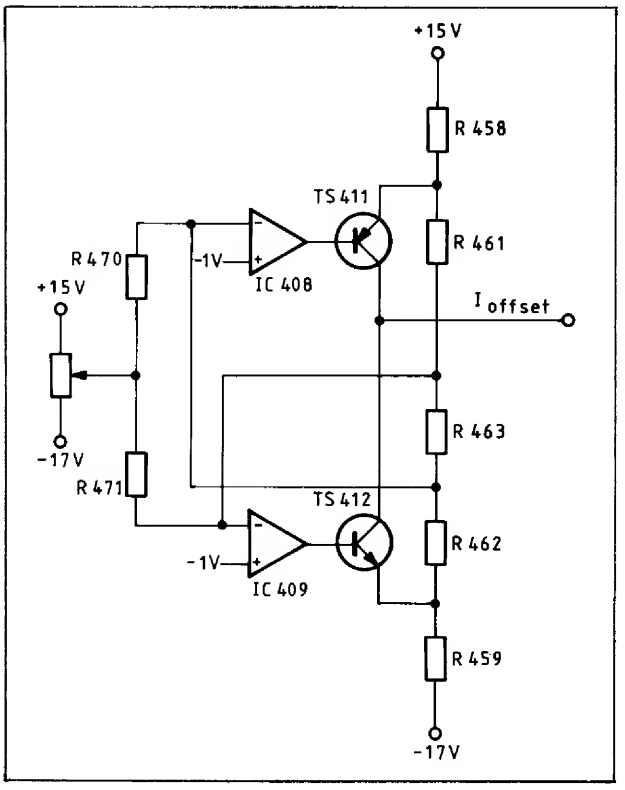
Another pair of diodes, GR407 and GR410, is fitted after the attenuator. They are connected to +6 V and -6 V in a similar way but with L502 connected between the output connector and the diodes. These diodes prevent the DC-level of the output waveform going above +6 V or below -6 V.

DC offset circuits

Positive DC offset is accomplished by feeding a DC-current to the output of the pulse generator and negative DC offset is accomplished by extracting a DC-current.



Two current generators, controlled by a single OFFSET potentiometer on the front panel, are used to generate these currents. They are connected together such that only one can generate current at a time and that the zero position of the potentiometer is expanded to simplify zero setting.



The circuit that expands the zero position of the potentiometer is the feedback from the voltage divider R461+R462+R463.

If the potentiometer is at the middle of its travel, it gives an output of -1 V and both outputs of the op-amps are switched off. The current through R458-R461-R463-R462-R459 is about 1 mA.

The voltage at the inverting input of IC408 (IC409) is then about -2.3 V (+0.3) holding the op-amp outputs safely high (low) and TS411 +TS412 switched off.

To increase the offset voltage, the pot must be turned sufficiently so that the current through R470 pulls the inverting input up above the -1 V reference level. When it does, TS411 starts conducting. A current starts flowing through R458 -TS411 and out through the I_{offset} output. Now the voltage drop over R458 increases giving negative feedback to the inverting input of IC408.

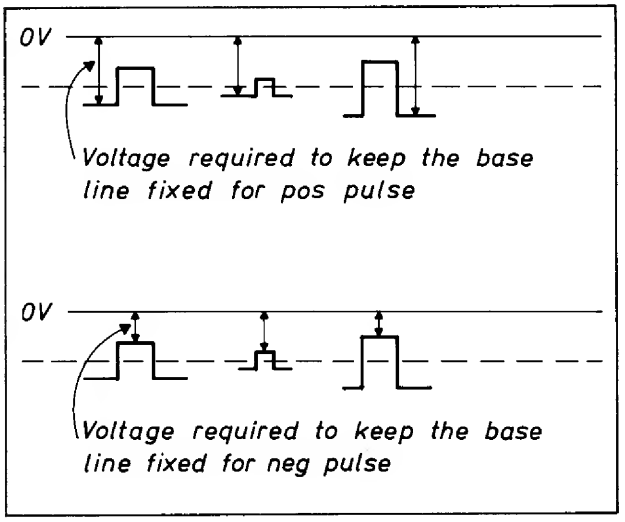
The I_{offset} output is connected to the output of the pulse generator via inductor L502 which stops the AC signal from entering the current generators.

The negative current generator built around IC409 works in the same way.

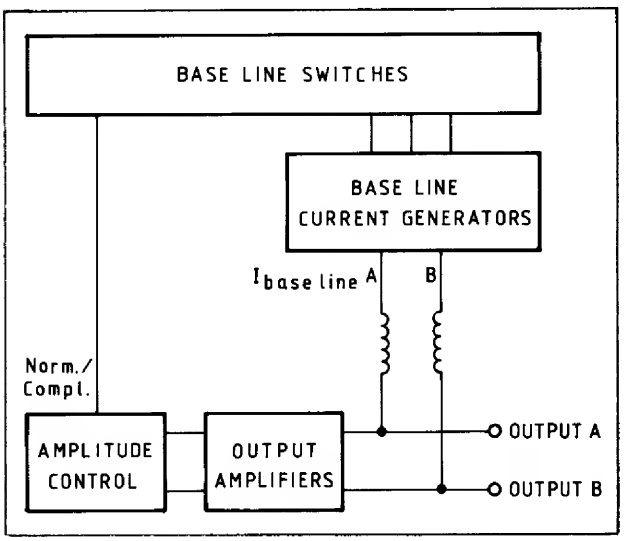
Base-line setting

The input signal to the output amplifier is always centred around -12 V.

The purpose of the base-line-setting circuits is to offset the waveform so that its base-line is fixed to the potential selected by the front-panel controls. i.e. Positive, negative or bipolar(positive for Output A and negative for Output B).



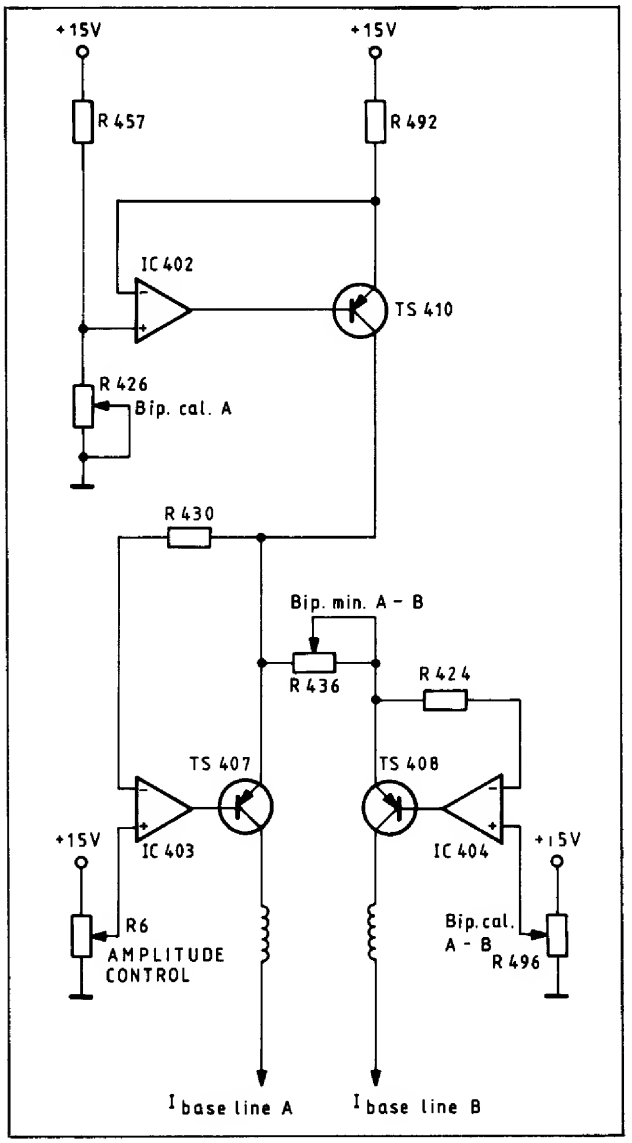
This is done by current generators in much the same way as the DC offset setting. However to keep the base-line fixed, the base-line-setting currents must vary when the AMPLITUDE control on the front panel is turned.



Bipolar base-line

When the bipolar switch is depressed, the current to Output A must increase with the amplitude while the current to Output B must decrease. The circuit is connected as shown in the diagram in the right-hand column.

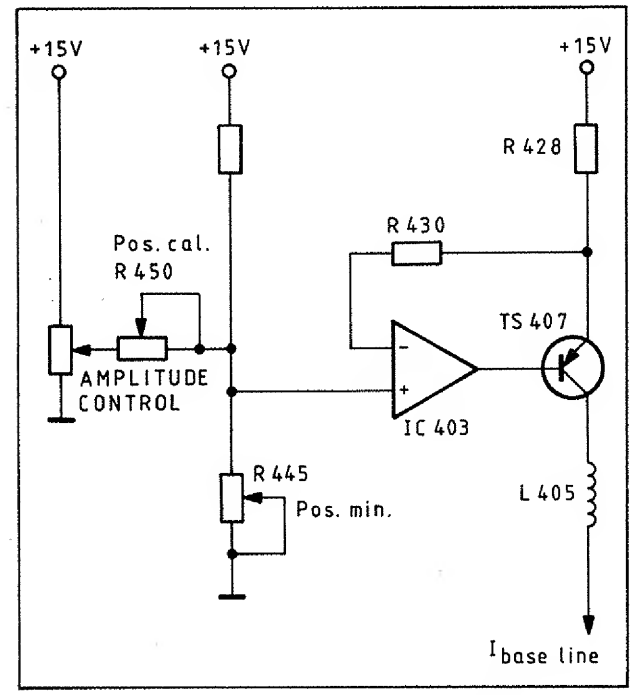
Current generator IC402/TS410 generates a constant current set by Bip cal A. This current is divided so that a larger current flows through TS407 than through TS408, positioning output A signal above the zero line and output signal B below it. The ratio can be adjusted by the Bip min A-B trimmer R436 and Bip cal A-B trimmer R496.



When the AMPLITUDE control is turned up, the current through TS407 increases. This makes the voltage at the emitter of TS407 drop. This voltage drop is sensed by the current generator IC403/TS408 which lowers $I_{base\text{-}line\ B}$ so that $I_{base\text{-}line\ A} + I_{base\text{-}line\ B}$ is constant.

Positive base-line

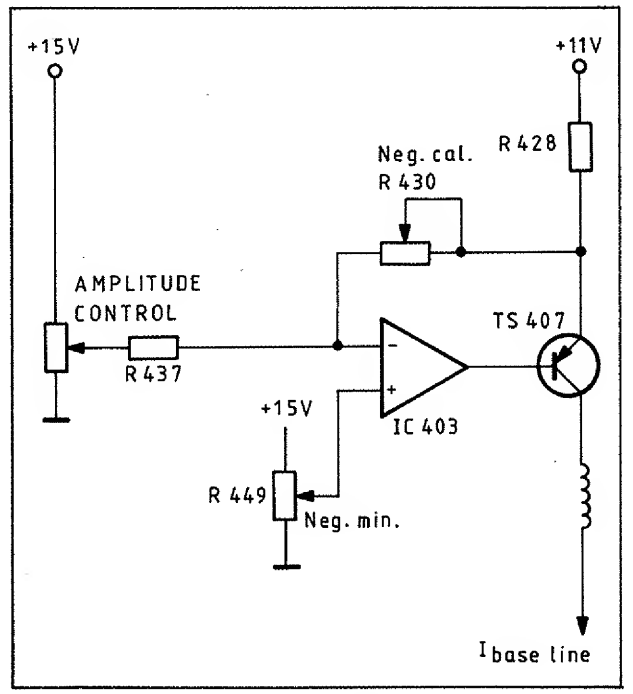
When the switches are set for positive base-line, the current generator for Output A and the current generator for channel B are driven in parallel. A set of trimmers for positive calibration are also switched in. The circuit for Output A is connected as in this diagram:



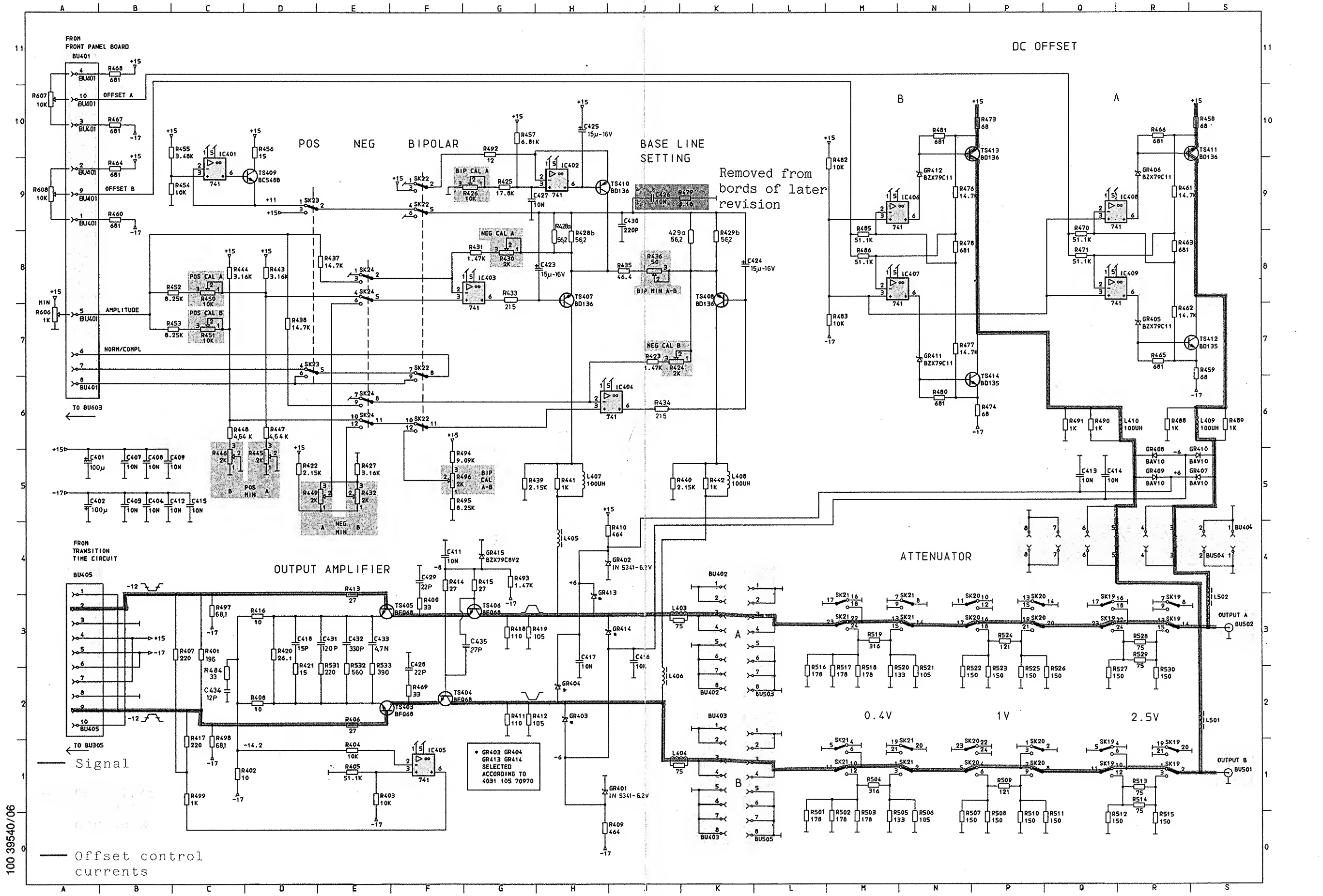
The circuit for Output B is connected in the same way.

Negative base-line

When the switches are set for negative base-line, the current generators are also driven in parallel but with a different set of trimmers and a lower drive voltage. The circuit for Output A is connected as in this diagram:

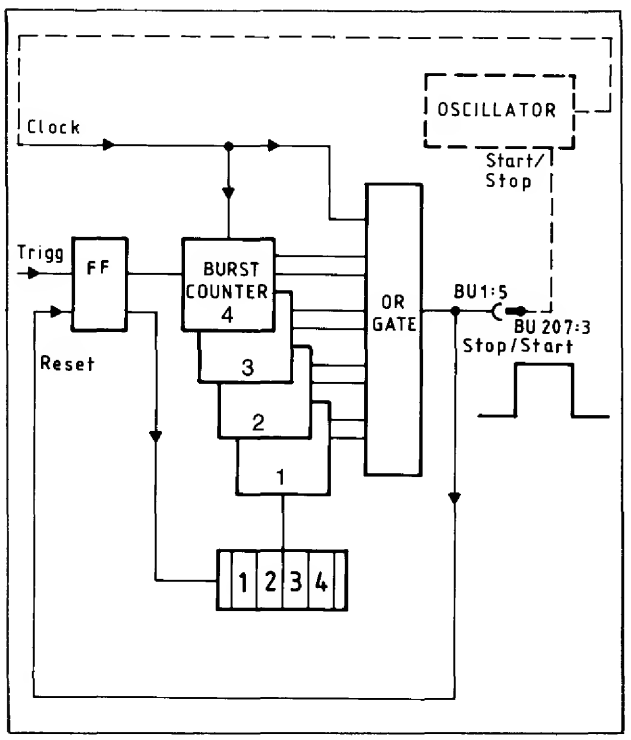


The circuit for Output B is connected in the same way.



Burst control board

The burst control board is fitted behind the four thumb-wheel switches on the front panel. These switches each preset one of the four burst counters which then counts the set number of pulses and stops the oscillator. This board is fitted to the PM 5786B only.



When a trigger pulse arrives from the external input or the SINGLE button, the flip-flop toggles and the four presettable decade counters are set with the current value of the thumb-wheel switches.

If that value is anything but 0000, some of the inputs to the OR-gate will go positive and so will its output. When the output goes high, the oscillator starts generating clock pulses. These pulses are fed to the clock input of the first decade counter. The divided-by-ten output of that counter clocks the next counter, and so on.

When the counters have counted the preset value, all their outputs are low. When the clock signal goes low, all inputs of the OR-gate are low, which makes its output go low and stops the oscillator.

The output signal also resets all counters and the flip-flop, so that the burst counter can be triggered again.

Setting the counter with the thumb-wheel switches

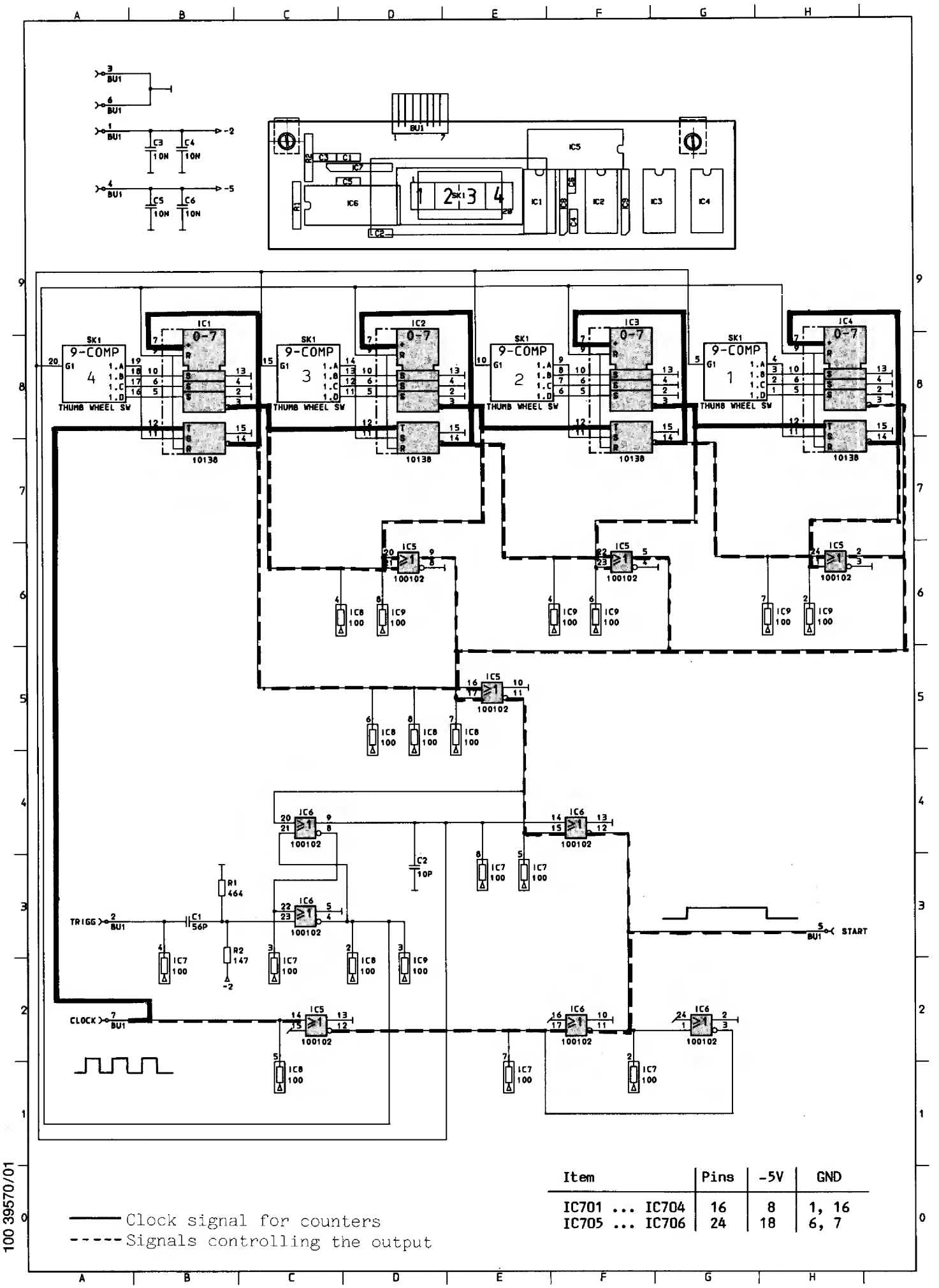
The thumb - wheel switches (SK701) out-put the 9th complement of the BCD-code; see table.

Thumb-wheel setting	Output code 8 4 2 1	Decade counter setting
9	0 0 0 0	0
8	0 0 0 1	1
7	0 0 1 0	2
6	0 0 1 1	3
5	0 1 0 0	4
4	0 1 0 1	5
3	0 1 1 0	6
2	0 1 1 1	7
1	1 0 0 0	8
0	1 0 0 1	9

When the thumb-wheel switch is set to e.g. five, the counter is preset to the 9th complement of 5. This means that the counter is actually set to 4, and it requires five clock pulses to count to nine. Nine occurs when both the first and the last bit of the counter output are high.

These two bits have inverted outputs on the counter circuit, so the counter actually outputs two low bits to the OR-gate. As mentioned earlier, when all inputs of the OR-gate are low, the output will go low and stop the oscillator.

UNIT 7 BURST CONTROL BOARD



Item	Pins	-5V	GND
IC701 ... IC704	16	8	1, 16
IC705 ... IC706	24	18	6, 7

——— Clock signal for counters

----- Signals controlling the output

100 39570/01

Power supply unit

The power supply consists of a mains transformer and a linear regulation board.

It generates four voltages: +15 V, -2.1 V, -5 V and -17 V. All outputs have current limiters.

A voltage selector and a fuse are located in the mains cable socket, and there are two replaceable thermal fuses in the transformer. See spare parts list for fuse ratings.

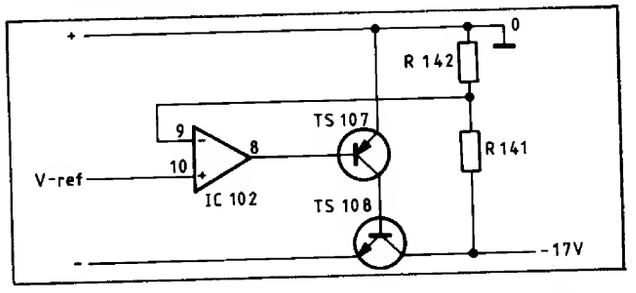
Voltage reference

A regulator type 79L05, IC103, generates a reference voltage of -5 V.

This reference is common to all voltage regulators except the -2.1 V regulator, which uses the output voltage from the -5 V regulator as a reference. This ensures that the -2.1 V is switched off if the -5 V fails.

The reference voltage is amplified to the desired output voltages by operational amplifiers in each voltage regulator.

Voltage regulation

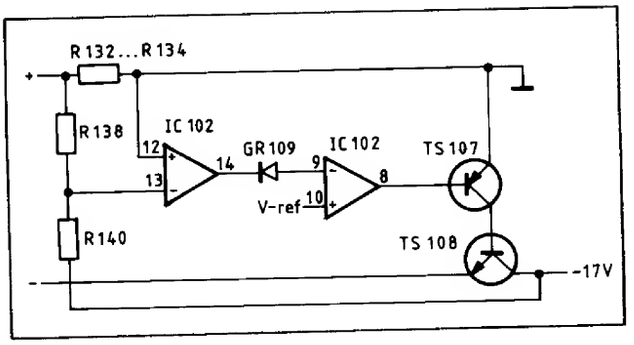


The reference voltage is fed to the inverting input of the +15 V op-amp, IC101 pin 6. It is also fed to the non-inverting input of the three negative voltage regulators.

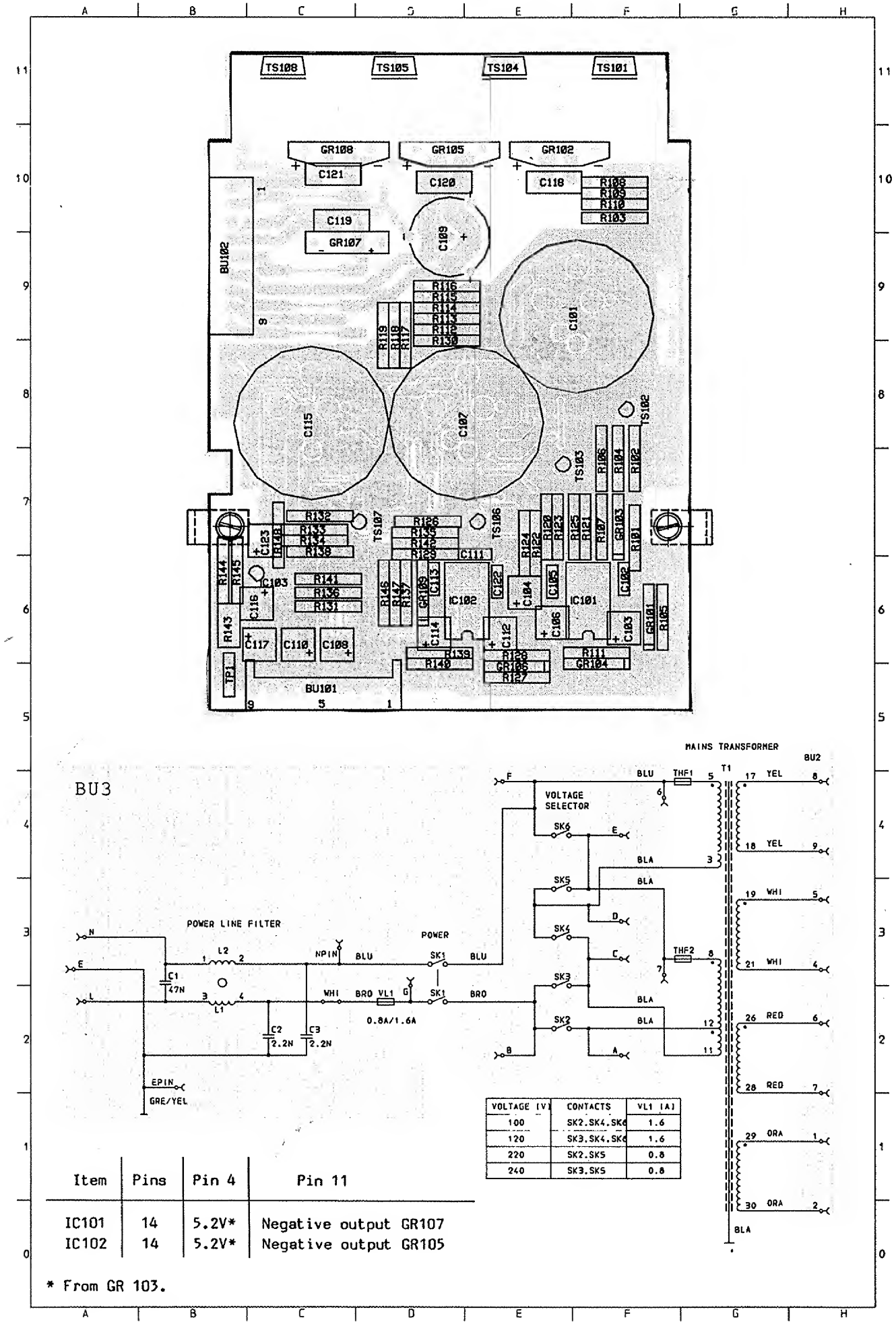
A voltage divider connected between the output of each regulator and ground determines the voltage on the other input of the op-amp. The voltage divider feeds back any variation in output voltage to the input of the op-amp which corrects the output voltage.

The output current of the op-amp is amplified by a small signal transistor and then drives the power transistor.

Current limiter



The current limiter consists of an op-amp which senses the voltage drop over a resistor connected in series with the output. When this voltage exceeds the reference voltage set by a voltage divider, the output of the op-amp pulls the inverting input of the voltage regulating op-amp low. This switches off the output current.

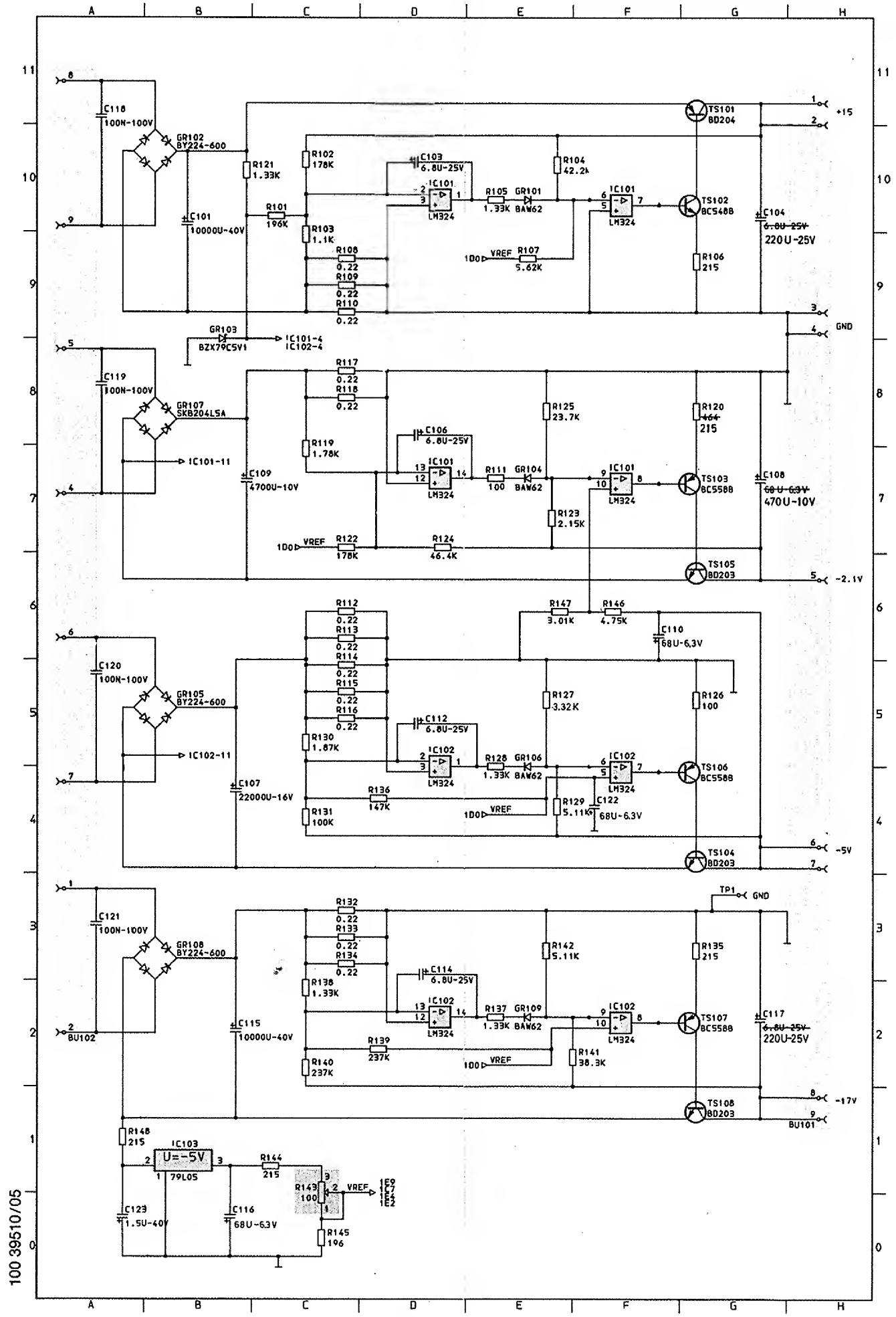


VOLTAGE [V]	CONTACTS	VL1 [A]
100	SK2.SK4.SK6	1.6
120	SK3.SK4.SK6	1.6
220	SK2.SK5	0.8
240	SK3.SK5	0.8

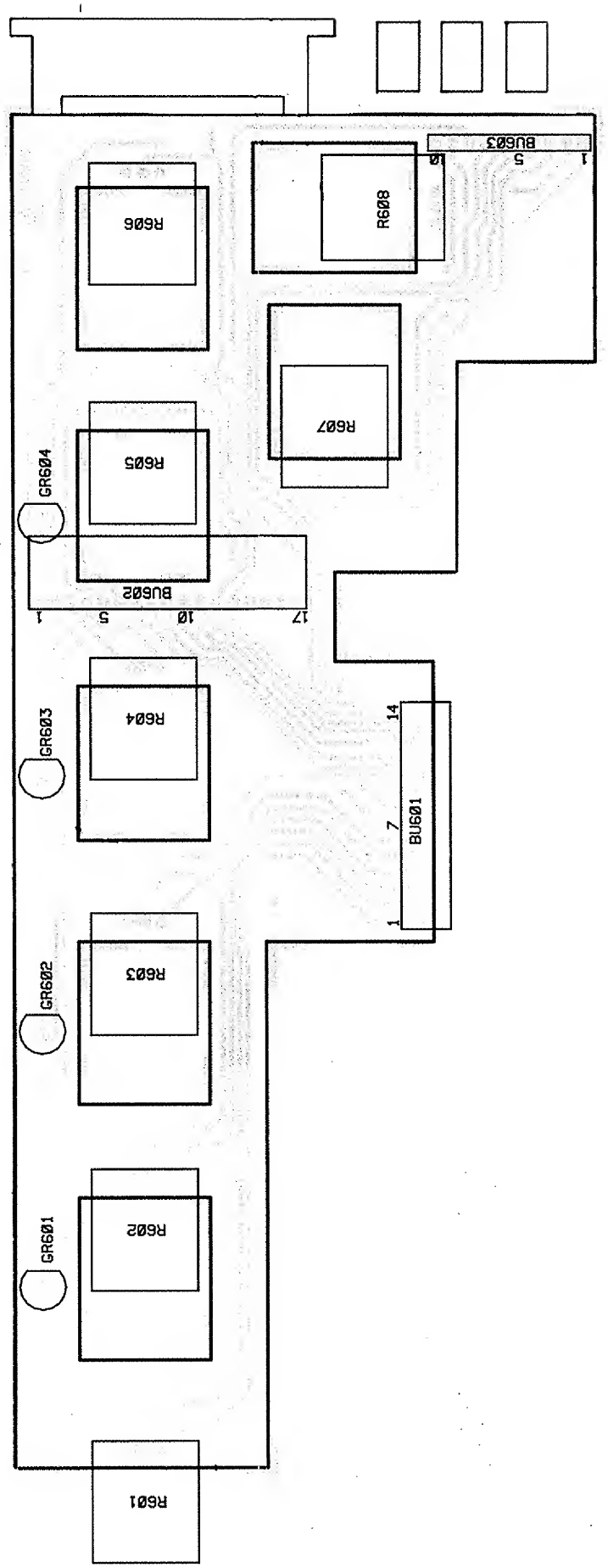
Item	Pins	Pin 4	Pin 11
IC101	14	5.2V*	Negative output GR107
IC102	14	5.2V*	Negative output GR105

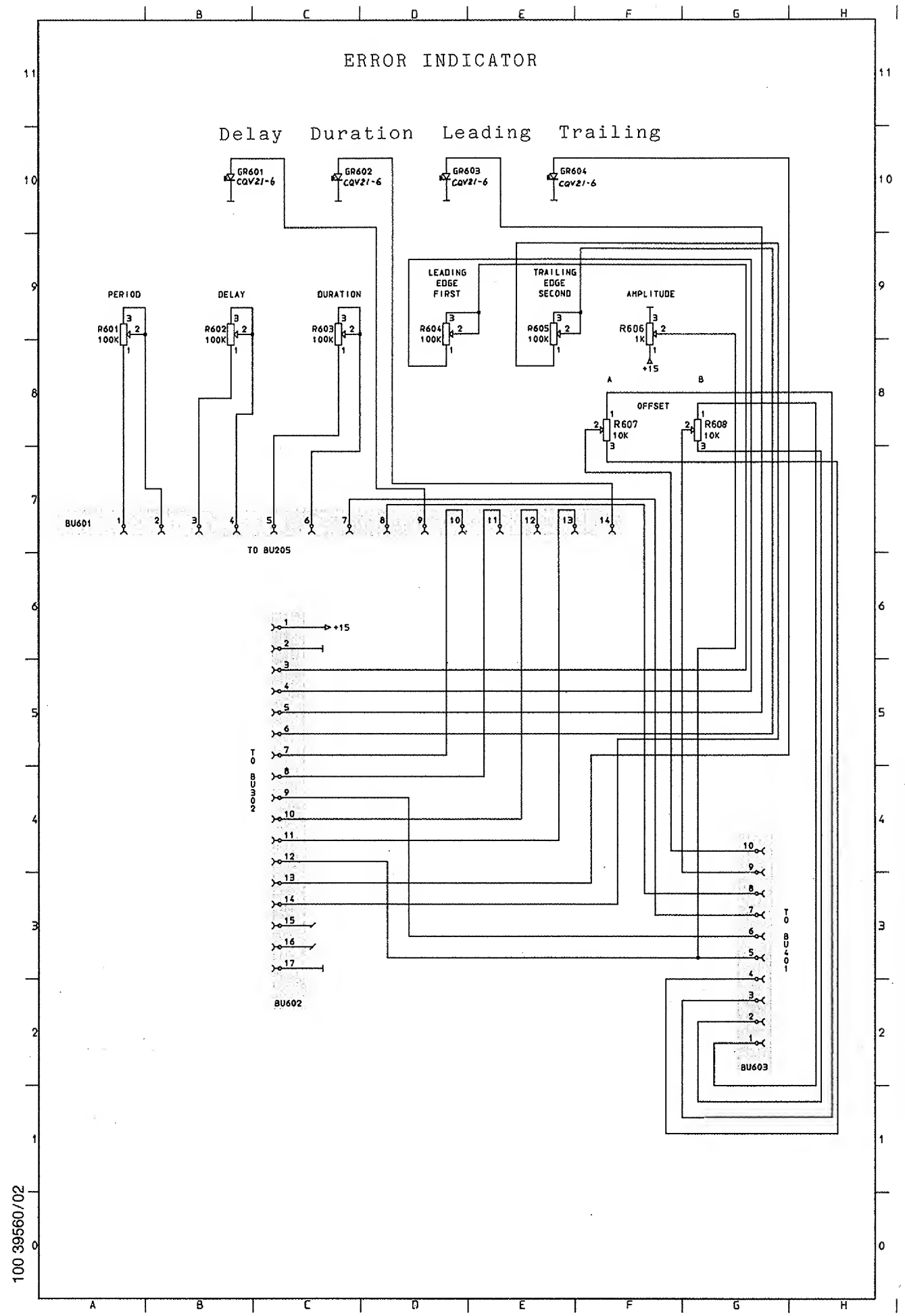
* From GR 103.

POWER SUPPLY, UNIT 1

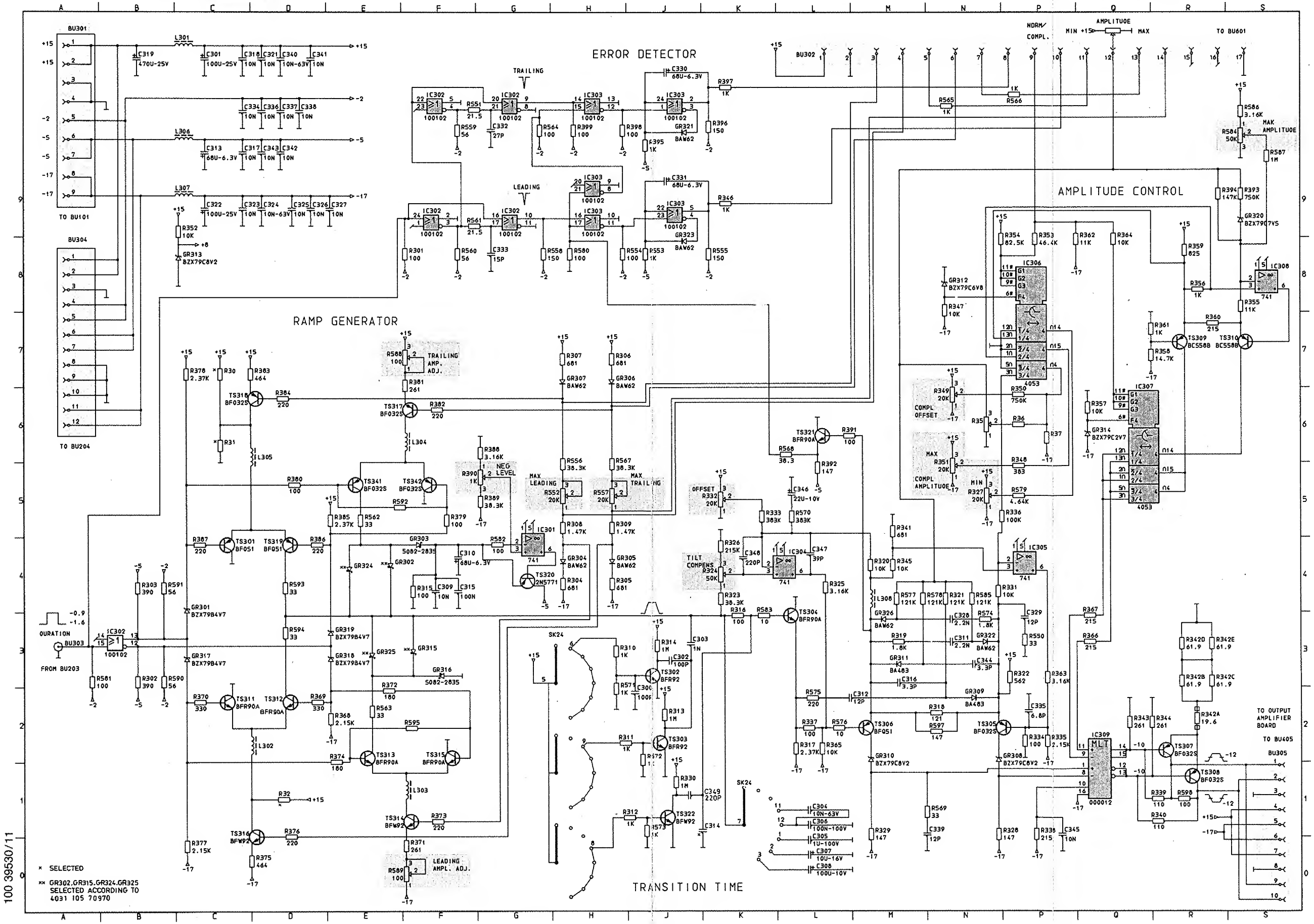


FRONT PANEL BOARD, UNIT 6

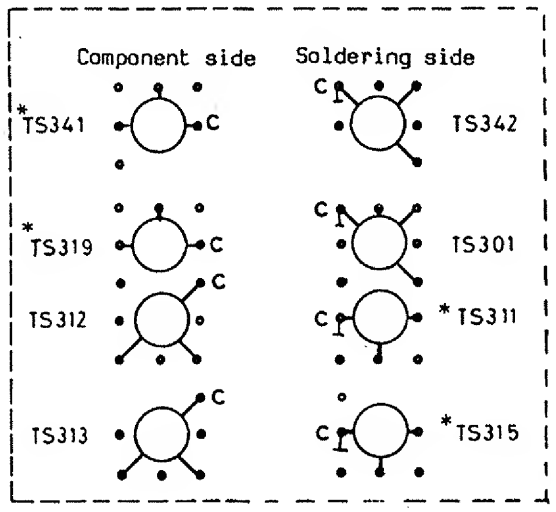




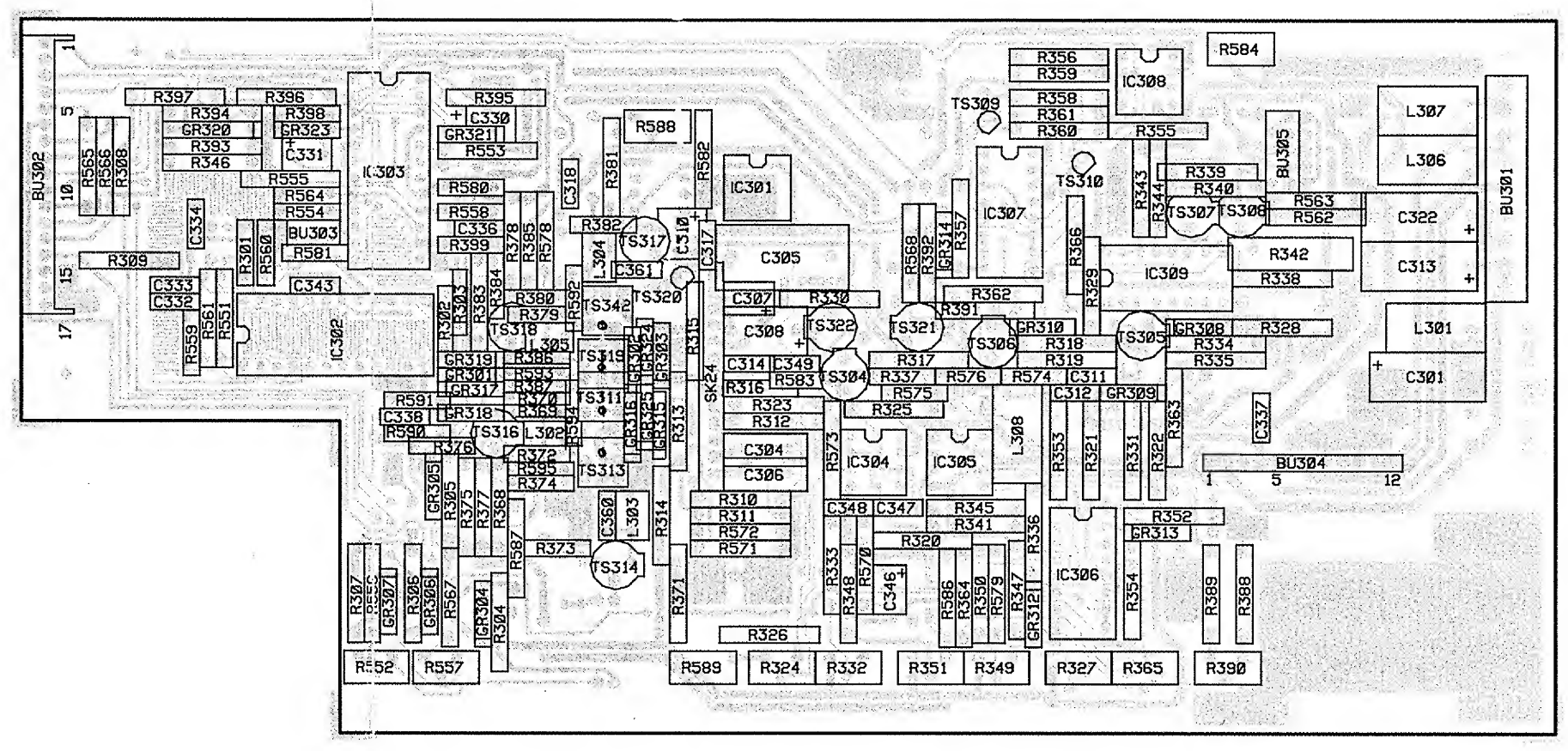
TRANSITION TIME BOARD, UNIT 3 Rev. 6

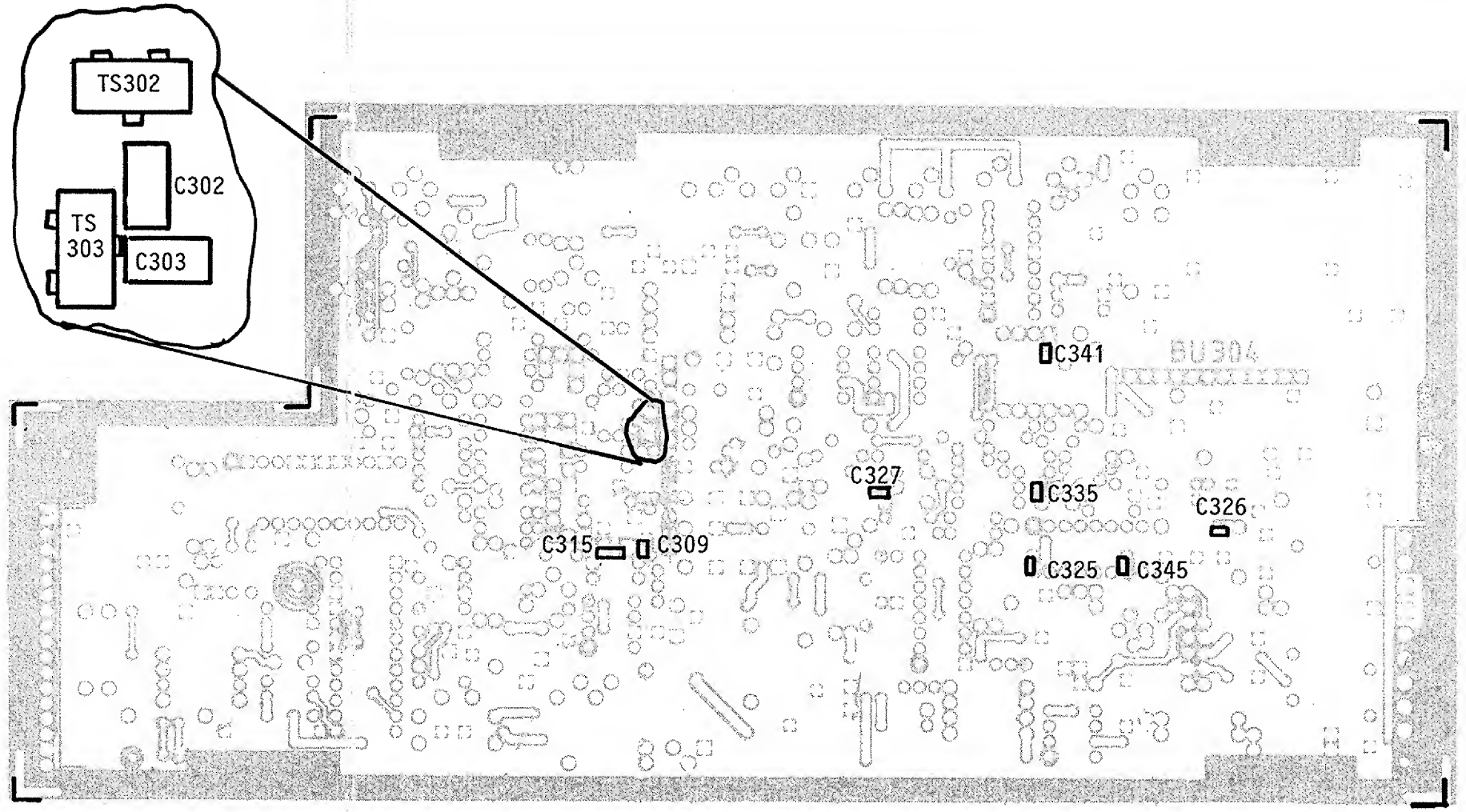


TRANSITION TIME BOARD, UNIT 3 Rev. 6



Component layout for transition generating transistors. Transistors marked with * are mounted upside down.





Chapter 5

FAULT-FINDING

CONTENTS

GENERAL INFORMATION

It is assumed that the service technician is familiar with the operation of the PM 5786. If not, study the operating manual and use the performance check as much as possible.

The fault-finding method for PM 5786 is based on a fault-finding tree. The tree is used to locate the faulty part of the generator; the more detailed fault-finding must be based on conventional methods with an oscillocope, and so on. This chapter gives some hints for each section how to find fault.

Remember that the PM 5786 is a fast pulse generator and for service applications a sufficiently fast oscilloscope must be used. A rise-time of less than 0.5 ns is required.

Due to the fast pulse technique used in the PM 5786, some components are mounted on top of other components. Do not move them, as it might force you to readjust a major part of the generator.

Be careful when working with the PM 5786 as many circuits (e.g. line receivers) are very sensitive to static discharges.

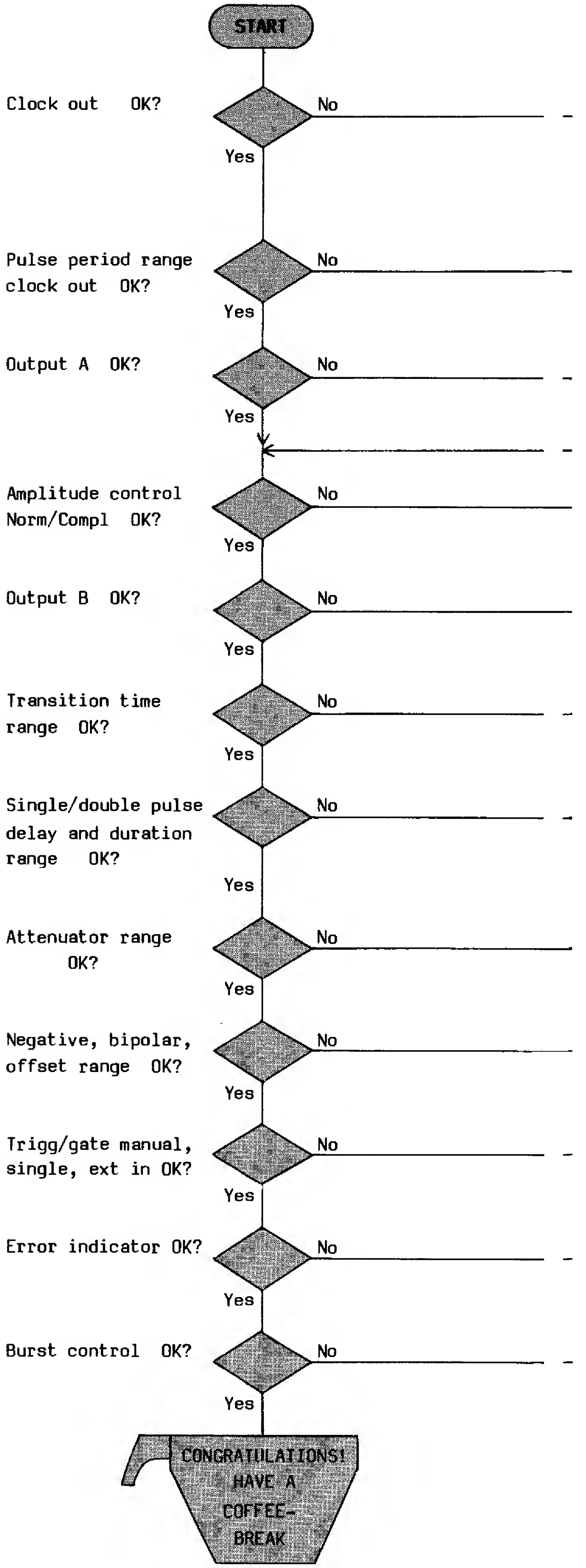
Some functions in the circuit diagram seem to be more complicated than appears necessary. The reason is that switching for the different functions is made by logic gates.

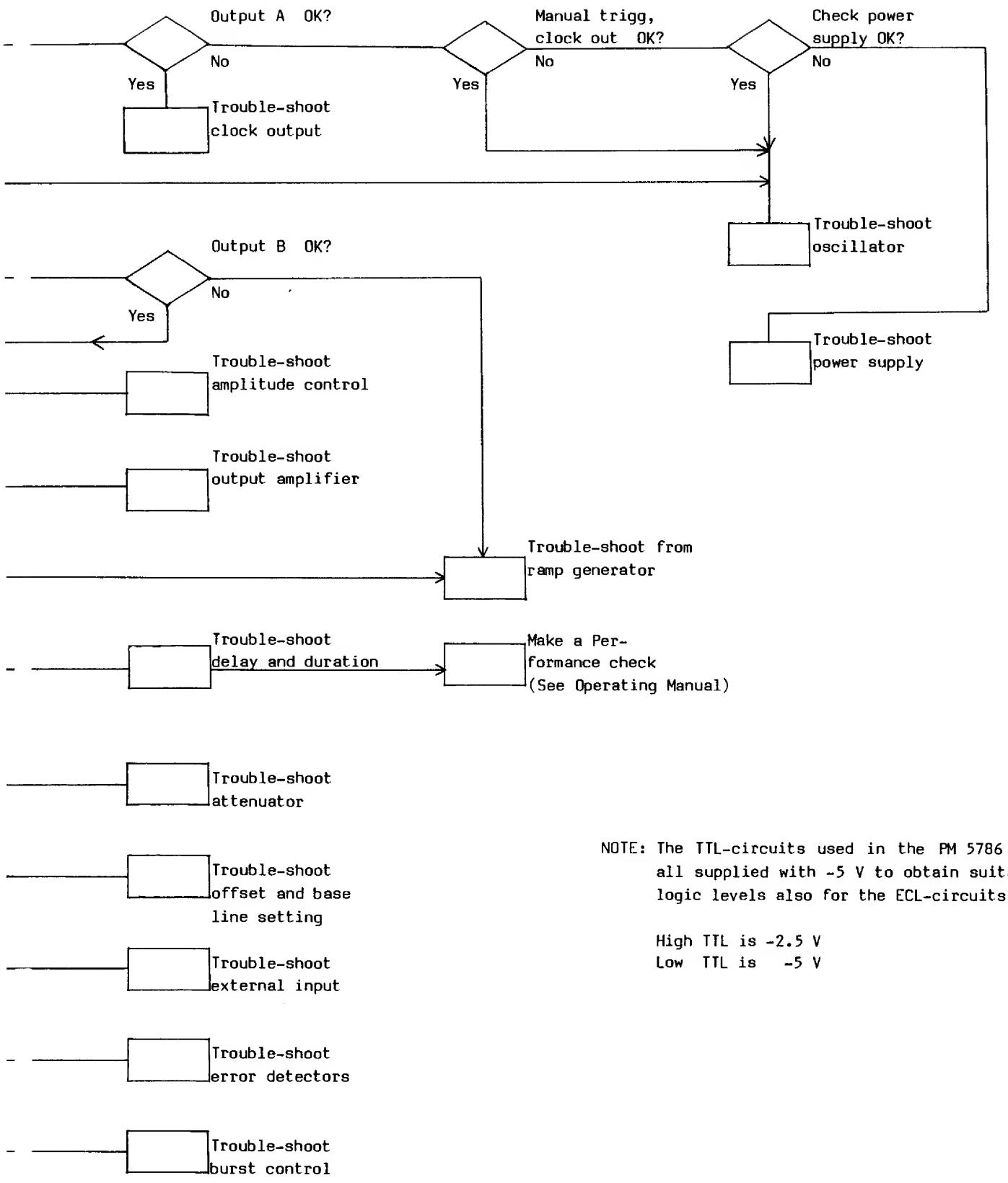
INITIAL SETTINGS

PULSE PERIOD .... minimum
PULSE DELAY .... minimum
PULSE DURATION .... minimum
TRANSITION TIME .... minimum
INT CLOCK .... depressed

EXT DUR or ⊓⊔ .... depressed
COMPL .... released
POS .... depressed
AMPLITUDE range .... 5 V
AMPLITUDE vernier .... min
OFFSET .... 0 V
BURST .... any value except 0000

Start in the upper left corner. Return to start after trouble-shooting and remedy of fault.





NOTE: The TTL-circuits used in the PM 5786 are all supplied with -5 V to obtain suitable logic levels also for the ECL-circuits.

High TTL is -2.5 V
Low TTL is -5 V

TROUBLE-SHOOTING

NOTE: The TTL-circuits used in the PM 5786 are all supplied with -5 V to obtain suitable logic levels also for the ECL-circuits.

High TTL is -2.5 V
Low TTL is -5 V

External input

To trouble-shoot the external input, connect a suitable signal source, 1 MHz 2 V_{pp}, to the input and follow the signal path via TS201,202 and IC201:16,14 and via the slope selection to IC202:15 and IC203:16. In trigger mode via IC202:17 to IC206:20 and in gate mode via IC204:24 to the oscillator.

Oscillator

Check on IC204:13 whether the oscillator is running or not, try the three fastest ranges. If not, check the conditions for the oscillator.

Check the +12 V supply to the oscillator on C211. IC204:15 must be on -1.3...-1.4 V when "Internal Clock" is selected. This is also valid for Gate and Burst mode when triggered. Ensure that no static discharges are produced on the line receivers.

Turn the PULSE-PERIOD potentiometer on the front panel and measure on R269 and R258 that both current generators are functioning.

When the oscillator is running, there should be symmetrical pulses on IC205:21. Follow the signal path through IC206:4 and :8 as well as IC203:2 and IC207:13. If this is OK then check the different dividers; start with range 1... 10 µs; the frequency on IC222:4 must be divided by five and on IC222:14 by 10. On range 10... 100 µs, check IC236:6; the frequency of the oscillator must be divided by 50. Check the other ranges in the same way. All outputs from IC233....235 to the inputs of IC236 should be high.

After a repair make sure that the oscillator is adjusted according to the adjustment procedure.

Clock output

Check on IC212:22 that the square-wave is present and then follow the signal path. After a change of components, check the output waveform, it should have a 1 ns rise-time and not too much overshoot and ringing.

Delay and Duration Circuits

Check that the positive- and negative-going short pulses are available at IC207:11 and 10. Check on IC210:5 that both the delayed pulse via IC207:4,3 / IC209:4,3 and the double pulse via IC208:10 are present.

If the fault is in the delay circuit, turn the delay setting and check the current generators by measuring the voltage variation on R753 and R748. Check on L204/205 that there is a negative-going ramp between high and low level. The duration circuit is checked in the same way.

Ramp generator

Measure the waveform before the ramp generator on IC302:15 and after the ramp generator on R316. If there is a fault, then check that the eight switching transistors are switching the four current generators correctly.

Turn the setting of ramp-time and check that the relevant current generators are changing. The amplitude limiting current (for leading edge) from TS314 shall be 1.5 times the current from TS318. For trailing edge, TS317 gives 1.5 times the current from TS316.

Amplitude control

Measure the signal before TS305/306 and after TS307//308. If the fault lies in between then read the circuit description and note the difficulty to measure because of the current control. Turn the amplitude control and check that the voltage drop over R366 and R367 changes inversely. Change also between normal and complementary pulse.

NOTE: After changes in Unit 3, always repeat the adjustment procedure.

Output Unit

Check BU405:1 and 2 for pulses with set rise- and fall-times. The centre of the pulse must be at -12 V.

Check the pulse at GR413/414 and GR403/404. If missing, look at the protection diodes. Four diodes go to + and - 6 V before the attenuator and another four diodes after the attenuator. Then there are two zener-diodes from the + and -6 V to ground. Don't change output transistors unless the diodes have been checked.

If you have changed an output transistor, then also change the protection diodes (at least the ones protecting the replaced transistor) as they most certainly will have been over loaded.

Base-line setting

If there are pulses on the output but the levels are not shifting correctly when the polarity switches negative /bipolar are activated, then check the protection diodes GR403, GR404 and GR413, GR414.

If they test OK, then check each current generator.

DC-Offset

Change DC-Offset and check that these four current generators are working properly. If not, check the four protection diodes GR407...410 and then the relevant current generator. If a protection diode is faulty, check also the four diodes GR403, 404 and GR413, 414 protecting the output transistors.

Attenuator

Change the attenuator setting to 2.5 V, 1 V and 0.4 V and check that both channels are divided in the right ratio. After a change of components in the attenuator check the waveform carefully for reflections.

Power Supply

Make sure that the pulse generator is set for correct mains voltage and remember that high voltages are present in the power supply.

Repair and maintenance of an opened power supply with the mains voltage on is dangerous and should only be carried out by personell aware of the risks involved.

Measure the four DC-voltages at BU101; they are set by the common voltage reference IC103. Adjustment of the voltage level shall be performed as described in Chapter "Adjustments".

Error Detector

The Error detectors for delay and duration are found on Sheet 2 of the timing circuit, only the LEDs are located on the front-panel board, Unit 6. The corresponding circuit for leading and trailing edges are located on Unit 3 with the outputs IC254 on Unit 2 and the LEDs on the front-panel board, Unit 6.

Read the circuit description for the relevant error detector and use equal length of cables and equal probes as the pulse timing is the important point.

Note that in double pulse mode, a too long or too short delay-time will give error detection and indication on the duration LED.

SAFETY INSPECTION AND TEST AFTER REPAIR

General directives

After repair in the primary circuit, take care that creeping distances and clearances have not been reduced.

Before soldering, component pins must be bent on the solder side of the board.
Replace insulating-guards and plates.

Safety components

Components in the primary circuit are important to the safety of the instrument and may only be renewed by components obtained from your local Philips organisation.

Check the protective earth connection

Visually check the correct connection and condition and measure the resistance between the protective lead at the plug and the cabinet. The resistance must not be more than 0.5 ohms. During measurement, the power cord should be moved. Any variations in resistanse indicate a defect.

Chapter 6

ADJUSTMENTS

CONTENTS

GENERAL INFORMATION

The following information provides the complete checking and adjusting procedure for the instrument. As various control functions are interdependent, a certain order of adjustment is often necessary.

The procedure is therefore presented in a sequence which is best suited to this order, cross references being made to any circuit which may affect a particular adjustment.

Before any check or adjustment, the instrument must attain its normal operating temperature.

- Warming up time under average conditions is 30 minutes.
- The instrument should be checked according to the performance check in the Operating Manual before any adjustment is made.
- All limits and tolerances given in this section are calibration guide-lines, and should not be interpreted as instrument specifications unless they are also published in Chapter 6 of the Operating Manual.
- Tolerances given are for the instrument under test and do not include test equipment errors.

REQUIRED TEST EQUIPMENT

- Sampling oscilloscope with a maximum rise-time of 0.5 ns, with FET-probe
- Counter, e.g. Philips PM 6654 with probe PM 8922
- Signal generator or a pulse generator, minimum frequency 130 MHz
- Oscilloscope
- Multimeter
- Extension cable kit 4031 100 44300
- 50 ohm termination
- Trimming screwdriver for 72P-type trimmers
- Screwdriver Pozidrive number 1
- Screwdriver Pozidrive number 2
- Screwdriver 5.5 mm
- Socket for knobs, 7 mm thin walled

POWER SUPPLY BOARD

Preparations

- Remove the top cover
- Connect the power and switch it on.

Adjusting the output voltage

- Connect the multimeter to the -5 V testpoint on the Timing Circuit Board.
- Adjust R143 until the meter reads -5.0... -5.05 V

Checking the output voltage

Measure that the voltages at the test-points on board 2, the Timing Circuit Board, are according to the table below.

Test-point	Measured voltage
-17 V	-16.9...-17.3 V
-5 V	-5.0...-5.05 V
-2.1 V	-2.1... -2.2 V
+15 V	+14.9...+15.3 V
IC251:14	+11.9...+12.1 V.

TIMING CIRCUIT BOARD

General set-up

Pulse generator

Control	Switch	Vernier
AMPLITUDE	2.5 V	Maximum
OFFSET	-	Mid-position (0V)
BIPOLAR/POS/NEG	Positive	
COMPL/NORMAL	Normal	

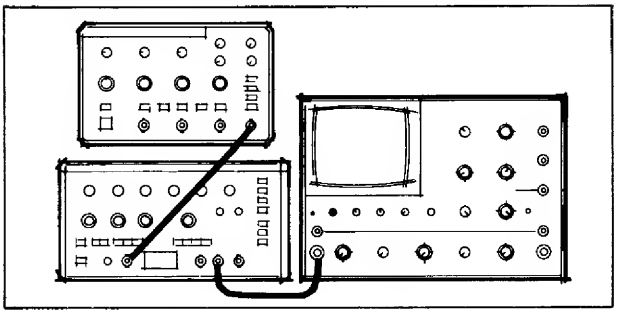
Timer/counter PM 6654

Control	Setting
TRIGGER LEVEL A&B	+1.25 V via keyboard
SLOPE	Positive
DC/AC	DC
x1/x10	X1
1 Mohm/50 ohm	50 ohm

It is recommended to store this setting in one of the P1...P7 programs.

Oscillator

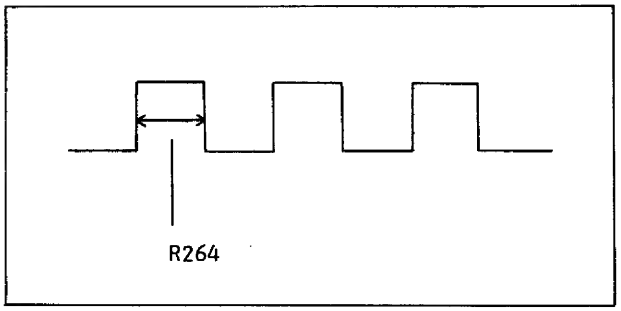
Adjusting the duration of the first pulse



- Connect EXT IN of the PM 5786 to the output of another pulse generator set to repetition time 10 µs and duration 5 µs.
- Connect OUTPUT A to the sampling oscilloscope.

- Set the PULSE PERIOD-switch 100 ns...1 µs and vernier to max.
- Depress EXT DUR or ⌐¬.
- Depress GATE or BURST.

- Adjust R264 until the first pulse has the same duration as the following pulses.



- Turn the PULSE PERIOD vernier to min. and check that first pulse still has the same relation to the following pulses.

Adjusting the pulse symmetry

- Depress INT CLOCK
- Set the PULSE PERIOD vernier to max.

- Adjust the pulse symmetry to 50 ±1% with R255.

- Turn the PULSE PERIOD vernier to min. and check that the pulse asymmetry is not more than ± 10 %.

Adjusting the minimum pulse period time

- Depress INT CLOCK and EXT DUR or ⊓⊔
- Set the PULSE PERIOD switch to 8...20 ns and the vernier to min. position.
- Connect CLOCK OUT to the Timer/Counter PM 6654.
- Select Period A on the counter.

- Adjust C200 until the counter shows a period time of 7.93...7.91 ns (126.1...126.4 MHz).

NOTE: C200 is missing on early p.c.b.s Adjustment is then made by soldering a small capacitor in parallel with C212. This capacitor must be fitted on the solder side of the p.c.b.

Adjusting the maximum pulse period time

- Set the PULSE PERIOD switch to 100 ns...1 µs and the vernier to max. position.

- Adjust R249 until the counter shows a period time of 1.1 µs.

Adjusting the overlap between ranges

- Check that the overlap between the ranges 8...20 ns, 20...100 ns and 100 ns...1 µs is approximately 10 %.

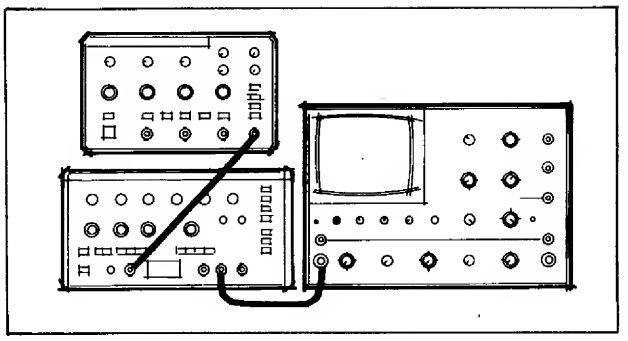
- Set the PULSE PERIOD switch to 100 ns...1 µs and the vernier to min.

- The period time must decrease to at least 94 ns, otherwise fit a resistor of 10 kohm or more in parallel with resistor R251.
- Readjust R249 and check all ranges.
- If the overlap is too large, remove any resistor soldered in parallel with R251.

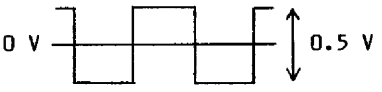
Checking the dividers for the 1µs...1 s ranges

- Check the rest of the PULSE PERIOD ranges. These ranges are a result of successive dividing by 10 of the 100 ns...1 µs range.
- Set the PULSE PERIOD switch to 100 ns...1 µs. and the vernier to min.
- Measure the period time with the counter.
- Turn the PULSE PERIOD switch clockwise to the next range and check that the period time is multiplied by ten, and so on up to the 100 ms..1 s range.

Adjusting EXT IN



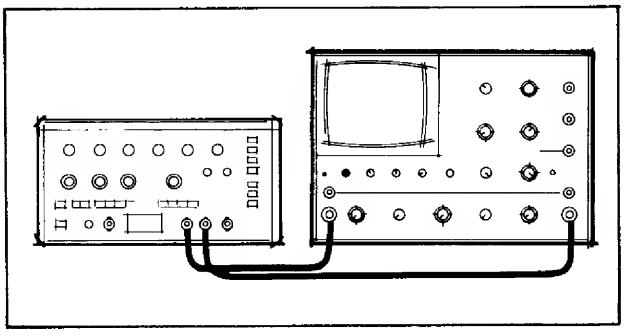
- Connect a symmetrical square-wave or sine-wave signal of 50...125 MHz, see figure below, to EXT IN; use a 50 ohm termination.



- Depress TRIGG.
- Release MAN.
- Depress EXT DUR or ⊓⊔
- Set LEVEL to mid-position, 0 V.

Adjust R211 until the output signal on OUTPUT A is as symmetrical as possible.

Adjusting the pulse delay time



- Connect CLOCK OUT to channel A on the sampling oscilloscope.
- Connect OUTPUT A to channel B on the sampling oscilloscope. Use the same cable length as for CLOCK OUT.
- Select 10 ns/div as time-base.
- Positive oscilloscope triggering

- Depress ⊓⊔⊓⊔ on PM5786.

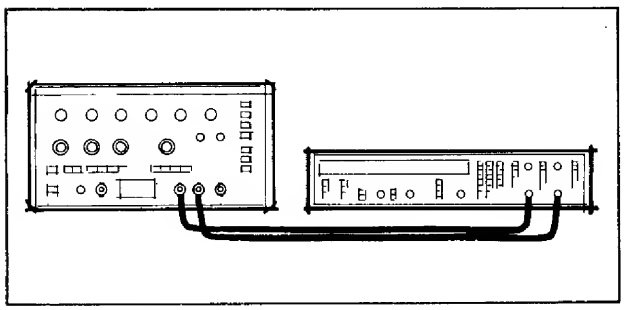
- Set the PULSE DELAY switch to 100 ns...1 µs and the vernier to min.
- Adjust the delay time (between the first and the second pulse) to 90 ns with R741.

- Set the PULSE DELAY switch to 8...20 ns and the vernier to max.
  Adjust R757 to a delay time of not less than 21 ns.
- Check the PULSE DELAY, in both min. and max. settings of the vernier, for the 8...20 ns and 20...100 ns ranges.

NOTE: R741 (MIN DELAY) affects both the minimum and maximum settings for all delay ranges. R757 (MAX DELAY) only affects the maximum setting of all delay ranges.

- Check that the time between the leading edge of CLOCK OUT and the leading edge of the first double pulse is approximately 14 ns.

Checking the pulse delay overlap



Using two cables of the same length:

- Connect CLOCK OUT to input A on the Timer/Counter PM 6654.
- Connect OUPUT A to input B on the same counter.
- Select TIME A-B on PM 6654.

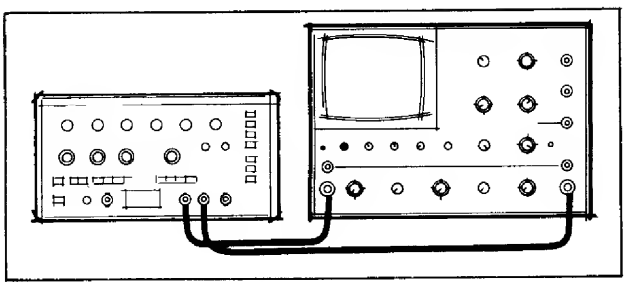
- Depress ⎍⎍ on PM 5786.

- Check that the overlap between the following ranges is more than 6 %.

100 ns...1 µs*
1* ...10 µs
10 ...100 µs
100 µs...1 ms
1 ... 10 ms
10 ...100 ms

* Note that displayed time on PM 6654 is 14 ns longer than actual time.
Do not forget to increase the PULSE PERIOD time to be longer than the delay time.

Adjusting the pulse duration time



- Connect CLOCK OUT to channel A on the sampling oscilloscope. Positive triggering.
- Connect OUTPUT A to channel B.
- Depress INT CLOCK.

- Depress ⎍⎍
- Set the PULSE PERIOD switch to 1...10 µs.
- Set the PULSE DURATION switch to 100 ns...-1 µs and the vernier to min.

- Adjust R793 for a duration time of 90 ns.
- Check the time between the leading edge of CLOCK OUT and the leading edge of OUTPUT A.

- Set the PULSE DURATION switch to 10...100 ns and the vernier to max.
- Adjust the duration time to 110 ns with R811.

- Use the sampling oscilloscope to check that the overlap between the ranges 3.5...10 ns and 10...100 ns is more than 6 %.

- Connect OUTPUT A to the Timer/Counter PM 6654.
- Select the counter function P WIDTH A.
- Check that the overlap between the ranges is more than 6 %.

100 ns...1 µs
1 ... 10 µs
10 ...100 µs
100µs... 1 ms
1 ... 10 ms
10 ...100 ms

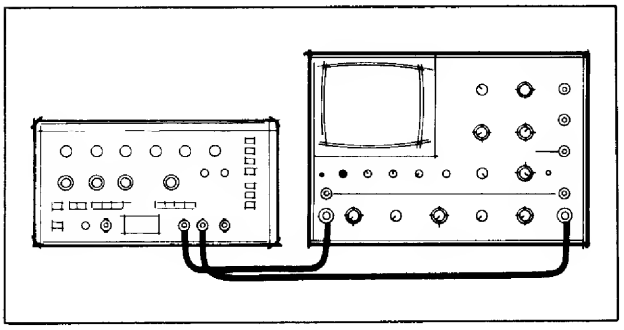
NOTE: Don't forget to increase the pulse period time so it is longer than the pulse duration time.

Adjusting the delay and duration error detectors

The error detectors for PULSE DELAY and DURATION are only activated when ⎍⎍⎎ and ⎍⎎⎍⎎ are selected, not when EXT DUR or ⎍⎎ is depressed.

If the timers are turned too far clockwise, the LEDs might turn on or flash even for correct pulses. To avoid this condition, proceed as follows:

- Pulse delay



- Connect CLOCK OUT to channel A on the sampling oscilloscope.
- Connect OUTPUT A to channel B on the sampling oscilloscope.

- Depress INT CLOCK.

- Depress ⎍⎍⎎
- Set PULSE PERIOD to 2 µs.
- Set the PULSE DELAY switch to 1...10 µs and the vernier to min.
- Set the PULSE DURATION switch to 100 ns... 1 µs and the vernier to min.

- Triggering on CLOCK OUT.
- Select 0.2 µs/div as the oscilloscope timebase.
- Arrange the screen so that the leading edge on CLOCK OUT is on the far left-hand side of the screen and the next leading edge is approx 10 divisions later.

- Increase PULSE DELAY with the vernier, until both the leading and trailing edges of the output signal just starts jittering, then STOP.
- Turn the trimmer R734 clockwise until the LED just turns on.

- Pulse duration

- Use the same oscilloscope connection as before.
- Depress INT CLOCK.

- Select ⎍⎎⎍⎎
- Set the PULSE PERIOD switch to 10...100 µs and the vernier to min.
- Set PULSE DELAY to 2.5 µs.
- Set the PULSE DURATION switch to 1...10 µs and the vernier to min.

- Select 0.5 µs/div as the oscilloscope timebase.
- Arrange the screen so that the leading edge of the first pulse starts at the far left position of the screen. The second pulse must start in the middle of the screen.

- Increase the pulse duration with the vernier.
- When the pulse duration becomes too long, the second pulse becomes wider than the first pulse. Note that the error indicator cannot indicate this.
- When pulse duration increases further, the second pulse becomes shorter again.
- Go on turning the vernier clockwise until the second pulse is as wide as the first pulse.
- In this position, turn the trimmer R786 clockwise until the LED just turns on and is stable.

TRANSITION TIME BOARD

Preparations

- Switch on the pulse generator and allow it to warm up for 30 minutes.

General set-up

Pulse generator

Control	Switch	Vernier
PULSE PERIOD	20-100 ns	Mid-position
PULSE DELAY	8-20 ns	Minimum
PULSE DURATION	3.5-10 ns	Minimum
TRANSITION TIME	2-10 ns	Minimum
AMPLITUDE	5 V	Maximum
OFFSET	-	Mid position (0V)
EXT DUR or ⊓⊔		
BIPOLAR/POS/NEG	Positive	

Sampling Oscilloscope

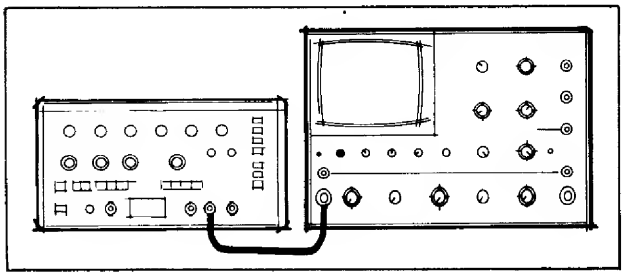
Control	Setting
TRIGG	B
MAGN	1
TIME/cm	10 ns
MODE	NORMAL
SENSITIVITY (YA, YB)	100 mV/cm
Y-POSITION A&B(without signal)	2 squares above lower edge

Timer/Counter

Control	Setting
FUNCTION	RISE/FALL A
TRIGGER LEVEL	AUTO
SLOPE	⌐
AC/DC	DC
ATTENUATOR	x1
INPUT IMPEDANCE	50 ohm

Ramp Generator

Adjusting the LEADING & TRAILING edge limiting diode current



Connect the oscilloscope to Output A

- Set PULSE PERIOD to 300 µs.
- Set the oscilloscope to 50 µs/cm.

- Adjust the current for the leading edge with R589, until the top line of the signal stays constant when the LEADING vernier is turned from min. to max.
- Adjust the current for the trailing edge with R588, until the top line of the signal stays constant when the TRAILING vernier is turned from min. to max.

CAUTION: Early units of the pulse generator have a faulty component layout screen print, where the text for LEADING and TRAILING trimmers are interchanged. Please use the component numbers R589 and R588 respectively as reference instead.

NOTE: If the high level of the signal cannot be satisfactorily adjusted, a resistor of 50 kohm...1 Mohm must be fitted in position R587.
If on the other hand, the low level of the signal cannot be satisfactorily adjusted, a resistor of 50 kohm...1 Mohm must be fitted in position R578. In some cases, R596 of 100 kohm...1 Mohm can be fitted.

Adjusting the Pulse Amplitude

- Depress the TRIGG button and turn the LEVEL potentiometer until the trigger-indicator is switched off.
- Connect a voltmeter between ground and pin 7 of the TRANSITION TIME SWITCH, SK301.

- Turn R390 until the voltmeter reads approximately -1.4 V. This will result in an output amplitude of 5 V approx.

CAUTION: Do not adjust R390 if not absolutely necessary, otherwise the output amplitude will need to be reset.

NOTE: The output amplitude must be checked when all trimmers on Units 3 and 4 have been correctly set. If the amplitude is not within 5.1...5.2 V it must be readjusted. In this case all settings made after the amplitude setting must be done again.

Amplitude Control

Adjusting the tilt compensation

- Set the PULSE PERIOD to 300 µs.
- Depress INT CLOCK.
- Set the oscilloscope TIME/cm to 50 µs.

- Adjust R324 until the top line and base-line of the pulse do not tilt.

Adjusting the offset at minimum amplitude

- Set the PULSE PERIOD switch to 20...100 ns and the vernier to mid-position.
- Depress the INT CLOCK button.
- Set the ATTENUATOR to 5 V and the AMPLITUDE vernier to minimum position.
- Set the sampling oscilloscope TIME/cm to 10 ns.

- Adjust R332 until the pulse is as well-shaped as possible on both leading and trailing edges.
- Check also for Output B.

Adjusting the offset at maximum amplitude

- Keep all settings from the previous test except the AMPLITUDE; set it to maximum position.
- Adjust R584 until the pulse is as well-shaped as possible on both leading and trailing edges.
- Check also for Output B.

Repeat the settings of R332 and R584, if necessary.

NOTE: R584 is normally put in mid-position. It must not be turned more than ±10 % from its mid-position. Otherwise it will be impossible to adjust Unit 4.

Adjusting the offset for complementary pulse

- Set PULSE PERIOD to 300 µs.
- Set the oscilloscope time-base to 50 µs/cm.
- Set the ATTENUATOR to 5 V and the AMPLITUDE potentiometer to maximum position.
- Depress the COMPL button.

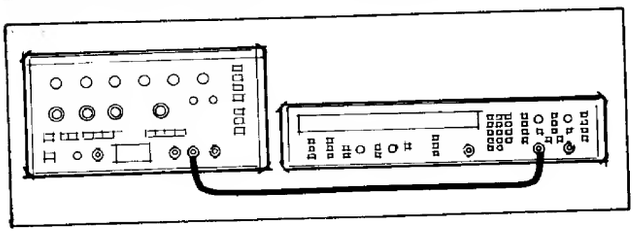
- Adjust the offset with R349 and the amplitude with R351 to the same values that are present when the COMPL button is not depressed.

- Turn the amplitude potentiometer to minimum position.

- Set R365 fully anti-clockwise and set the amplitude with R327 to the same value that is present when the COMPL button is not depressed.

NOTE: This measurement can also be made with a PM 6654 Timer/Counter set to measure V_{max} and V_{min}. In this case, set TRANSITION TIME to 100 ns.

Adjusting the transition time switch overlap



- Connect the PM 6654 to Output A and set it according to 'General Set-Up' (page 6-7).
- Set the PULSE PERIOD switch to 100 µs...1 ms and the vernier to minimum position.
- Set the TRANSITION TIME switch to 1...10 µs.
- Set the LEADING vernier to min.

- Check that the rise-time for the leading edge is approximately 0.9 µs (900 ns).
- Set the LEADING vernier to max and adjust R552 until the rise-time for the leading edge is approximately 11 µs.
- Change the SLOPE setting on the PM 6654 to ⌐
- Set the TRAILING vernier to min. and check that the fall-time for the trailing edge is approximately 0.9 µs (900 ns).
- Set the TRAILING vernier to max. and adjust R557 until the fall-time for the trailing edge is approximately 11 µs.

Measure both maximum and mimimum transition time for the ranges between 1 µs and 100 ms by using the counter. Use the sampling oscilloscope for the 2...10 ns and 10...100 ns ranges.

- Measure in all positions of the TRANSITION TIME switch. Check that there is at least 10 % overlap for all ranges except for the 2...10 ns range.

NOTE: Be sure to set the PULSE PERIOD so that you always get pulses with maximum amplitude.

NOTE: The automatic trigger level setting of the counter cannot be used when checking with the longest period times. Measure V_{max} and V_{min} and program the trigger levels to 10 and 90 % via the keyboard.

Checking the transition time error detectors

Check that the error indicators light when the amplitude of the signal has decreased to 50 % ± 10 % of full amplitude.

- Set the PULSE PERIOD switch to 8...20 ns and the vernier to max.
- Set the TRANSITION TIME switch to 10...100 ns and the verniers for LEADING and TRAILING to min.
- Depress INT CLOCK
- Depress EXT DUR or ⌐¬

- Turn the LEADING vernier and check that the LED over the vernier lights when the amplitude of the pulse is reduced to half of the original amplitude. Turn the vernier back to min.
- Repeat the above procedure for the TRAILING vernier.
- Turn the PULSE PERIOD vernier to min (8 ns).
- Turn both TRANSITION TIME verniers to min (2 ns) and check that non of the LEDs are incorrectly switched ON.
- Set PULSE DELAY and PULSE DURATION to minimum (8 ns and 3.5 ns respectively).
- Depress ⌐¬
- Turn the PULSE PERIOD vernier from min. to max. and then back again while checking that the LEDs remains switched off.
- Turn the PULSE PERIOD switch to 100 ns...1 ms while checking that the LEDs remains switched off (it is not necessary to turn the vernier).

OUTPUT AMPLIFIER BOARD

Preparations

- Switch on the pulse generator and allow it to warm up for 30 minutes.

General set-up

Pulse generator

Control	Switch	Vernier
PULSE PERIOD	1-10 µs	Maximum
TRANSITION TIME	2-10 ns	Minimum
AMPLITUDE	5 V	Maximum
OFFSET	-	Mid-position (0V)
EXT DUR or ⌐¬	Depressed	
INT CLOCK	Depressed	
BIPOLAR/POS/NEG	Positive	

Sampling Oscilloscope

TRIGG	B
MAGN	1
TIME/cm	2 µs
MODE	NORMAL
SENSITIVITY (YA, YB)	100 mV/cm
Y-POSITION A&B(without signal)	2 squares above lower edge

Output amplifier

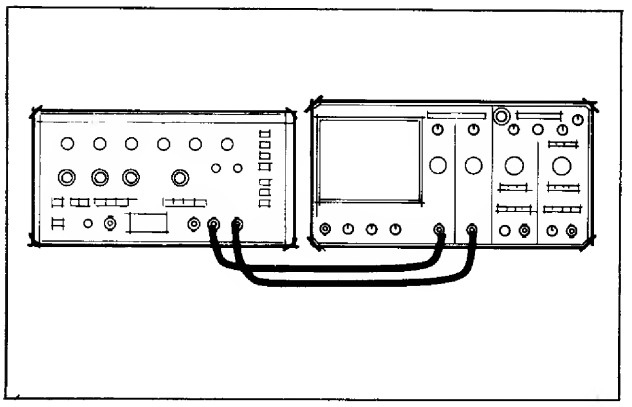
Amplitude check

- Measure on Output A and B of the pulse generator and tune with R390 until both channel outputs are between 5.0...5.2 V.
- Check that the amplitude stays within the 5.0...5.2 V range even in NEG, BIPOLAR and COMPL mode.

NOTE: After readjusting R390, all previous adjustments must be done again.

Base-line circuits

Adjusting the base-line in NEG output mode



- Connect both the A and B outputs to the oscilloscope.
- Set the sensitivity of the oscilloscope to 0.5 V/cm, 50 µs/cm.
- Set the time-base of the oscilloscope to 50 µs/cm.
- Set the TRANSITION TIME switch to 2...10 ns and the vernier to min.
- Set the PULSE PERIOD to 300 µs.

- Set the AMPLITUDE potentiometer to max.
- Adjust the base-line on Output A to 0 V with R430(NEG CAL A) and on Output B with R424(NEG CAL B).

- Set the AMPLITUDE potentiometer to min.
- Adjust the base-line on Output A to 0 V with R449(NEG MIN A) and on Output B with R432(NEG MIN B).

- Repeat this procedure until the base-line moves as little as possible when the amplitude potentiometer is turned.

Adjusting the base.line in POS output mode

- Use the same set-up as in the previous test.

- Set the AMPLITUDE potentiometer to max.
- Adjust the base-line on Output A to 0 V with R450(POS CAL A) and on Output B with R451(POS CAL B).

- Set the AMPLITUDE potentiometer to min.
- Adjust the base-line on Output A to 0 V with R445(POS MIN A) and on Output B with R446(POS MIN B).

- Repeat this procedure until the base-line moves as little as possible when the amplitude potentiometer is turned.

Base-line adjustment in BIP output mode

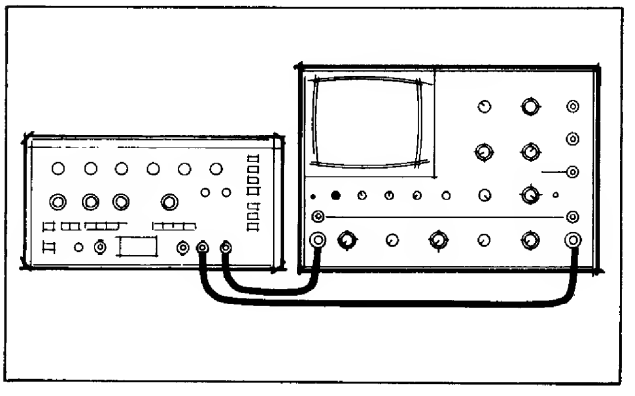
- Use the same set-up as in the previous test.
- Set the AMPLITUDE potentiometer to max.
- Adjust the base-line on Output A to 0 V with R426(BIP CAL A).
- Balance A and B channels so that both base-lines are at 0 V by turning R496(BIP CAL A-B).
- Set the AMPLITUDE potentiometer to min.

- Adjust the base-line on Output A and B to 0 V with R436(BIP MIN A-B).
- Repeat this procedure until the base-line moves as little as possible when the amplitude potentiometer is turned.

NOTE: On early units of the pulse generator, the time constant for the amplitude potentiometer is 10 seconds. When using such an instrument, avoid making any readings until 10 s after the potentiometer has been turned.

- Check that the zero level of the oscilloscope is still at 0 V by removing the input cables. If the level has changed, repeat all base-line adjustments.
- Check the base-line in POS/COMPL, BIPOLAR and NEG/NORMAL mode.
- If the base-line cannot be adjusted satisfactorily, Unit 3 must be re-adjusted.

Adjusting for low pulse distortion



- Connect Output A and B to the sampling oscilloscope. Set the PULSE PERIOD switch to 20...100 ns and the vernier to maximum.

- Depress EXT DUR or ⊓⊔
- Depress POS
- Depress 5 V
- Set the AMPLITUDE potentiometer to max.
- Set the sensitivity of the oscilloscope to 0.1 V/cm.

- Measure the overshoot on the leading and trailing edges for both outputs simultaneously, the pulse ringing (p-p) must not exceed 10 %.

- Depress COMPL and repeat the measurement.
- Depress NEG and repeat the measurement.
- Release COMPL and repeat the measurement.

- If the overshoot is more than 10 %, a capacitor must be fitted between ground and the junction of R316 and R583 on the transmission time board. A 1.0, 1.2 or 1.5 pF capacitor can be fitted.

NOTE: The rise- and fall-times become longer when a capacitor is fitted. Check that the rise- and fall-times are according to specification after fitting a capacitor.

Checking the rise- and fall- times

Use the same set-up as in the previous test.

- Measure the rise- and fall-times for both outputs simultaneously, it must not exceed 2.2 ns.
- Depress COMPL and repeat the measurement.
- Depress NEG and repeat the measurement.
- Release COMPL and repeat the measurement.

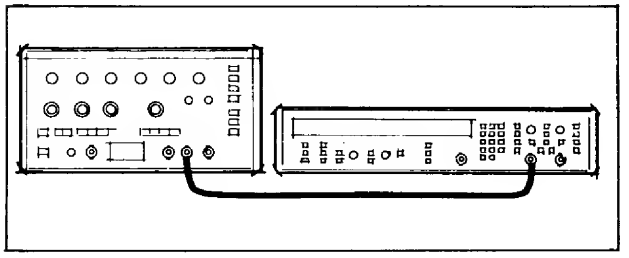
- Depress POS and set the AMPLITUDE potentiometer to min.
- Measure the rise- and fall-times for both outputs simultaneously, it must not exceed 2.4 ns.
- Depress COMPL and repeat the measurement.
- Depress NEG and repeat the measurement.
- Release COMPL and repeat the measurement.

- If the edges are too slow, a smaller capacitor must be chosen between ground and the junction of R316 and R583.

ATTENUATOR BOARD

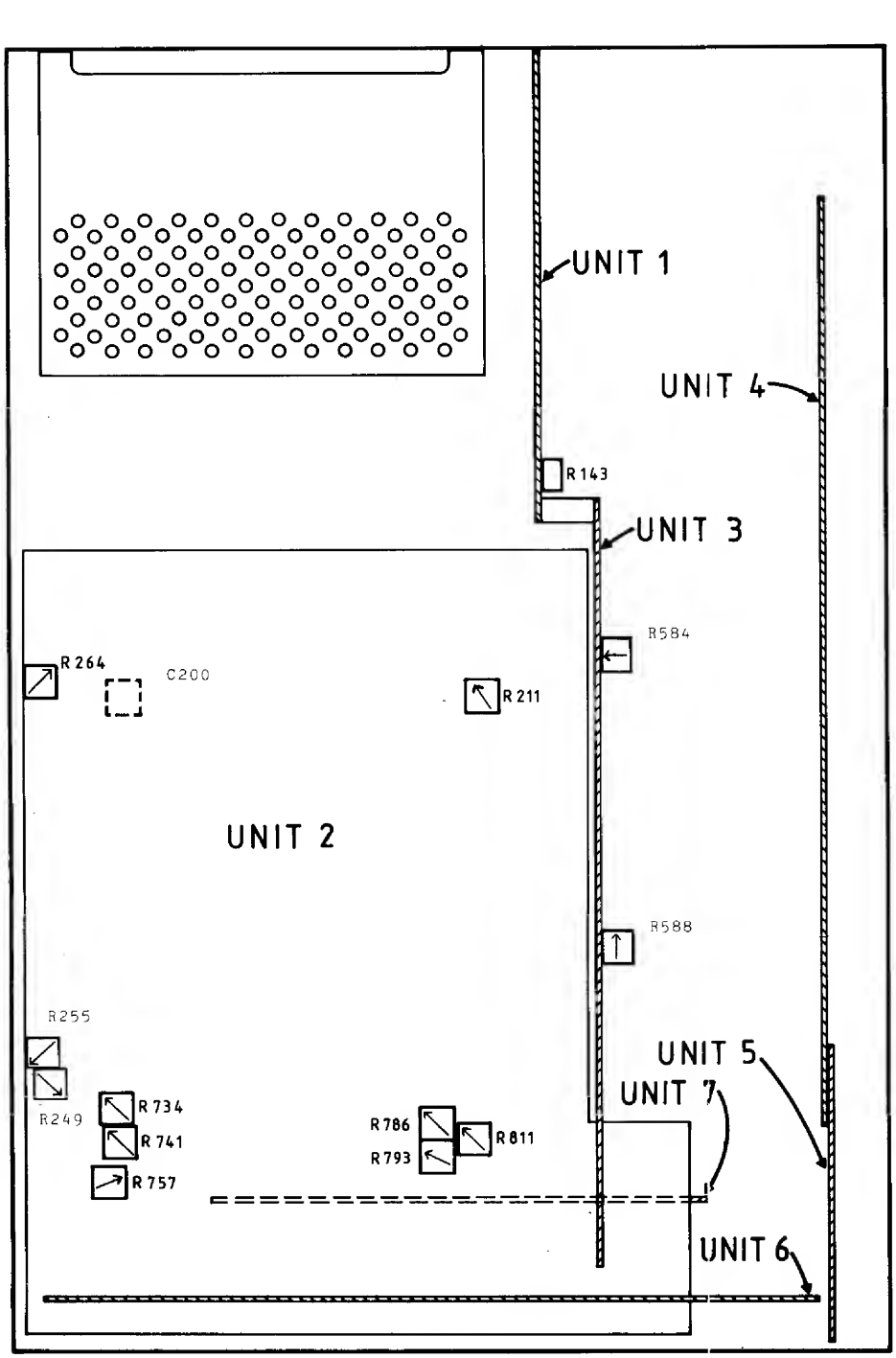
Checking the Attenuator

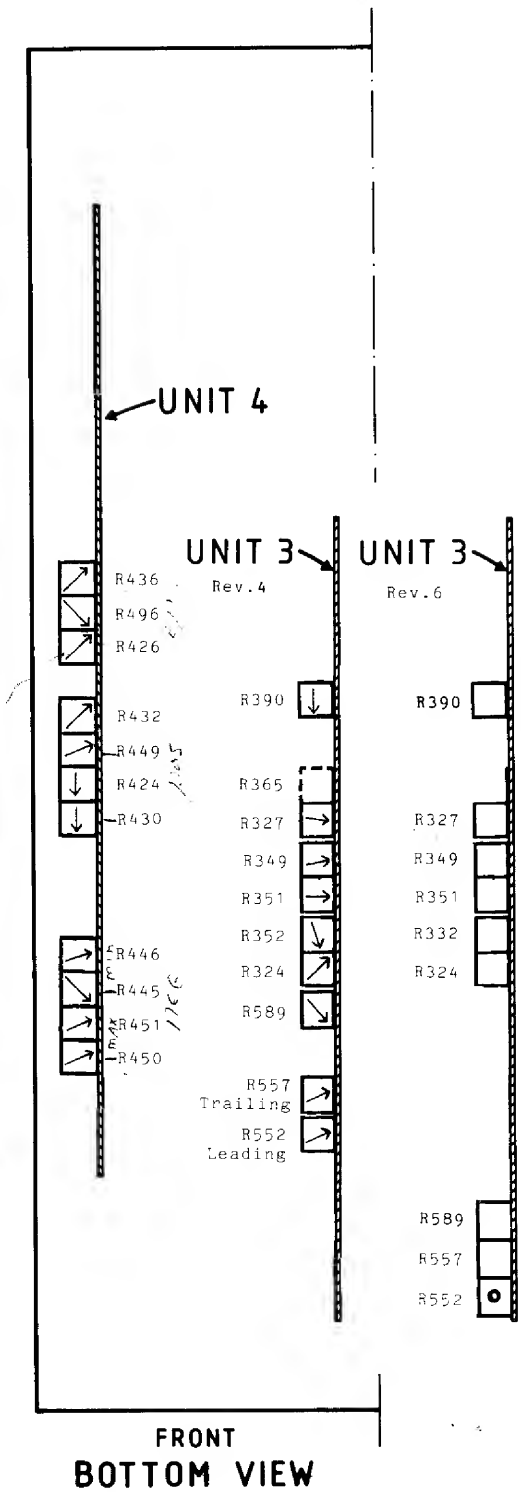
It is not necessary to perform this test unless a component in the attenuator has been replaced.



- Connect Output A to the A input of PM 6654.
- Depress Bipolar.
- Set the counter for measuring V_{pp} A.
- Depress the 5 V button on the Attenuator and set the Amplitude potentiometer so that the counter reads 5.0 V.
- Depress the 2.5 V key and check that the counter shows an amplitude of 2.36...2.64 V.
- Depress the 1 V key and check that the counter shows an amplitude of 0.94...1.06 V.
- Depress the 0.4 V key and check that the counter shows an amplitude of 0.37...0.43 V.

FINDING THE TRIMMERS





Green arrows indicate trimmer settings which can be used as start settings before making a complete adjustment of the pulse generator. Set the trimmers according to the arrows if you get stuck with the adjustments. then start all over again from the beginning of this chapter.

Chapter 7

SPARE PARTS

CONTENTS

NOTE: Overscored factory codes instead of order numbers means that no Order No. is available at time of publication.

Example:

Pos. No.	Order No.	Description	
BU203	~~4031-100-39670~~	Cable Assy, Mini-coax - Mini coax	130 mm

REPLACEMENTS

Standard parts

Electrical and mechanical replacement can be obtained through your local Philips organisation or representative. However, many of the standard electronic components can be obtained from other local suppliers. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE: Physical size and shape of a component may affect the instrument's performance, particularly at high frequencies. Always use direct replacements unless it is known that a substitute will not degrade the instrument's performance.

Special parts

In addition to standard electronic components, some special components are used:

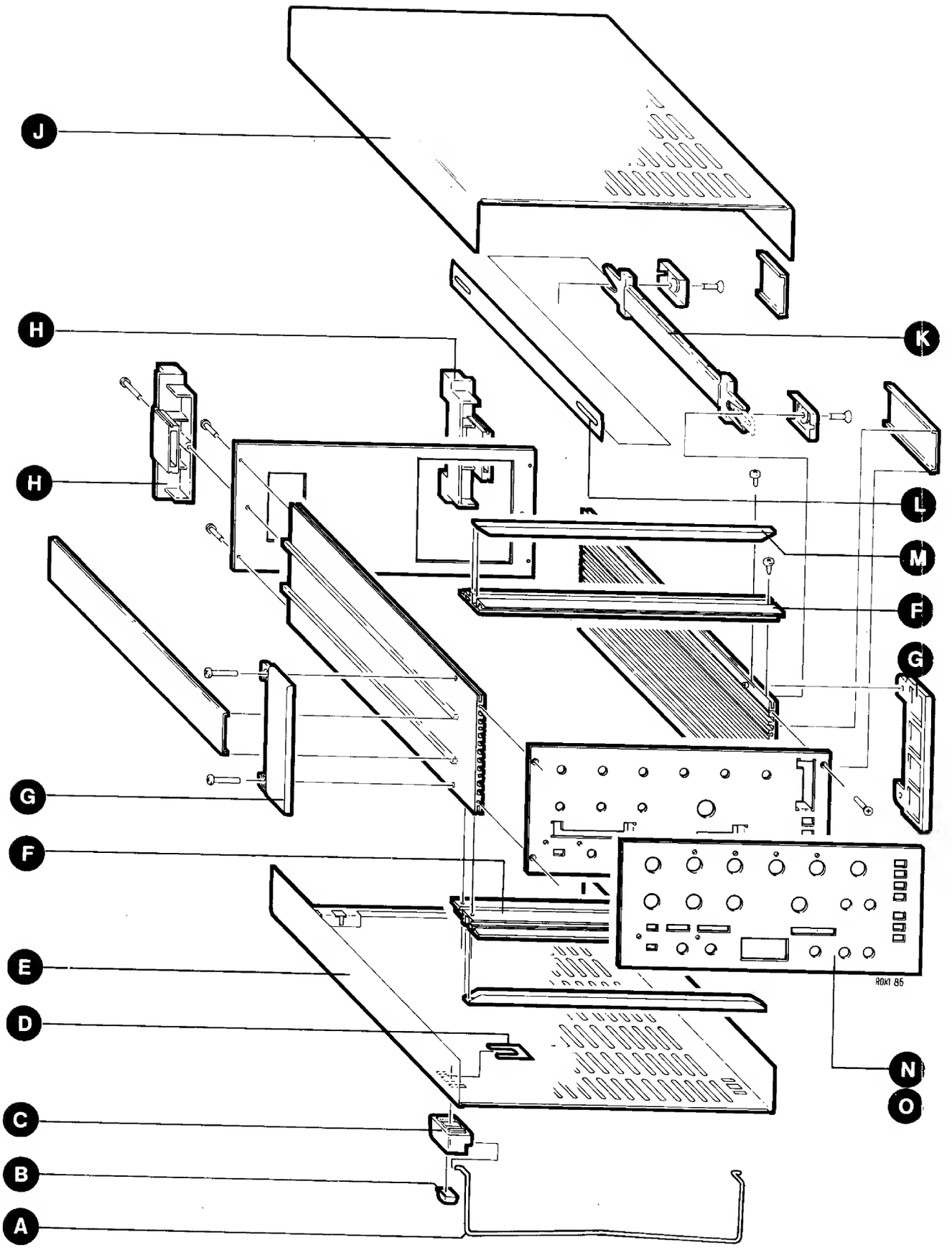
- Components, manufactured or selected by Philips to meet specific performance requirements.
- Components that are important for the safety of the instrument.

Both type of components may only be replaced by components obtained through your local Philips organisation.

SPARE PARTS LIST FOR PM 5786 AND PM 5786B

Mechanical parts

Pos. No.	Order No.	Description
A	5322 405 90313	Tilting support
B	5322 462 44434	Rubber foot, self adhesive
C	5322 462 40756	Plastic foot
D	5322 492 64745	Locking clip for plastic foot
E	5322 447 90546	Bottom cover
F	5322 460 60389	Front panel edging, upper/lower
G	5322 460 60388	Sidepiece, front
H	5322 462 40792	Rear bumper
J	5322 456 90109	Top cover
K	5322 498 50176	Handle
L	5322 462 40759	Steel insert for handle
M	5322 460 60391	Ornamental profile with text
N	5322 456 90111	Text plate for PM 5786B
O	5322 456 90112	Text plate for PM 5786
	4031 100 44300	Service kit containing extension cables NOTE: This kit must be ordered from your national Philips service organisation


J
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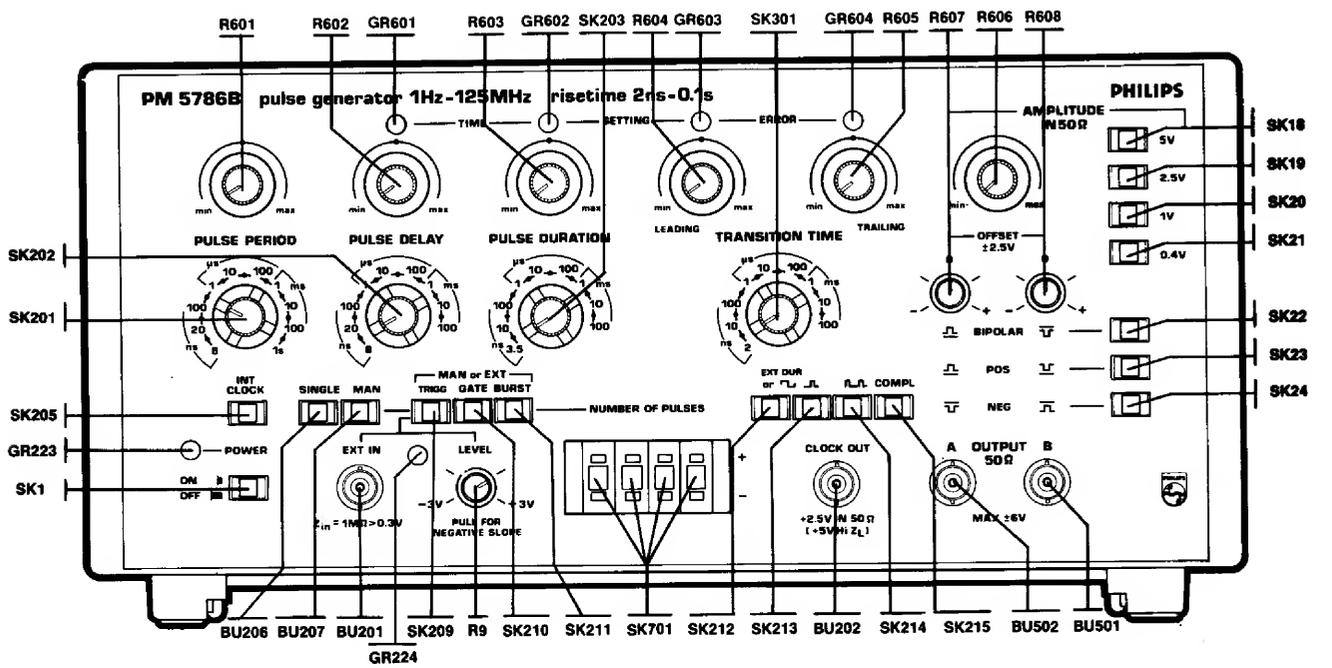
ROKI 86

Front-panel controls

Pos. No.	Order No.	Description		
KNOBS AND BUTTONS				
	5322 414 30056	Knob for OFFSET A and B pot	10 mm	3.2 mm spindle
	5322 414 30044	Knob for TRIGGER LEVEL pot	10 mm	4 mm spindle
	5322 414 70016	Cap for knob	10 mm	
	5322 414 40027	Knob 14 mm for PERIOD, DELAY and DUR. + TRANS. TIME + AMPL. vernier		
	5322 414 70017	Cap for vernier knob	14 mm	
	5322 414 70022	Nut cover for vernier knob	14 mm	
	5322 414 30038	Knob 18.7 mm for PERIOD, DELAY and DUR. + TRANS. TIME switch		
	5322 414 70015	Cap for switch knob.	18.7 mm	
	5322 414 20033	- Push-button for all push switches		browm 6x10 mm
SK1	5322 535 91233	POWER switch extension bar	266 mm	
SK22...24	5322 535 91232	- OUTPUT MODE switch extension bar	48 mm	
CONNECTORS				
BU201	5322 267 10004	EXT IN connector,	BNC	chassis-mounted
BU201	5322 321 21166	EXT IN cable assy,	200 mm	mini-coax - BNC
BU202	5322 267 10004	CLOCK OUT connector,	BNC	chassis-mounted
BU202	5322 321 21165	CLOCK OUT cable assy,		mini-coax - BNC
BU501, 502	5322 321 21166	OUTPUT A or B cable assy,	200 mm	mini-coax - BNC
BU501, 502	5322 267 10004	OUTPUT A or B connector,	BNC	chassis-mounted
INDICATORS				
GR223, GR224	5322 130 32813	POWER and TRIGG LEDs	Yellow	5 mm
GR223, GR224	5322 255 40423	Holder, POWER and TRIGG LEDs		
GR601...604	5322 130 32686	ERROR LEDs, CQV21-6	Red	5 mm
POTENTIOMETERS				
R601...605	5322 101 30537	VERNIER potentiometer	100 kohm ±10 %LOG	Cond. plastic
R606	5322 101 20818	AMPLITUDE potentiometer	1 kohm ±20 % LIN	Cond. plastic
R607, 608	5322 101 20819	OFFSET potentiometer	10 kohm ±20 % LIN	Cond. plastic
R9	5322 101 60074	Trigger level switch with	100 kohm potentiometer	Carbon track
SWITCHES				
SK1	5322 276 14358	Mains switch		
SK18...21	5322 276 40341	ATTENUATOR push switch assy.		
SK22...24	5322 276 30326	OUTPUT MODE push switch assy.		
SK201	5322 273 10144	PULSE PERIOD switch, rotary		
SK202	5322 273 10145	PULSE DELAY switch, rotary		
SK203	5322 273 10145	PULSE DURATION switch, rotary		
SK205...211	5322 276 60231	INT CLOCK, SINGLE, MAN, TRIGG, GATE and BURST push switch assy.		
SK212...215	5322 276 40339	EXT DUR, SINGLE, DOUBLE and COMPL push switch assy.		
SK301	5322 273 10146	TRANSITION TIME switch, rotary		
SK701	5322 277 10835	BURST thumb-wheel switch assy.		

Front-panel controls

Pos. No.	Order No.	Description



Power Supply, Unit 1

Pos. No.	Order No.	Description		
BU101	5322 267 50558	Connector 2145-C	MOLEX	9-pin
BU102	5322 268 14152	Connector 2391	MOLEX	9-pin
BU3	5322 121 42422	Mains filter with 5x20 mm fuse-holder and power inlet		
BU3	5322 256 30271	Fuse-holder for 6.35x32 mm fuse		
C101	5322 124 41059	Capacitor 10000 µF ±20 %	Electrolyt.	35 V
C103	5322 124 14081	Capacitor 6.8 µF ±20 %	Solid Alu.	25 V
C104	4822 124 40209	Capacitor 220 µF ±20 %	Electrolyt.	25 V
C106	5322 124 14081	Capacitor 6.8 µF ±20 %	Solid Alu.	25 V
C107	5322 124 41058	Capacitor 22000 µF ±20 %	Electrolyt.	16 V
C108	5322 124 21349	Capacitor 470 µF ±20 %	Electrolyt.	10 V
C109	5322 124 41057	Capacitor 4700 µF +50-10 %	Electrolyt.	10 V
C110	5322 124 10455	Capacitor 68 µF ±20 %	Solid Alu.	6.3 V
C112	5322 124 14081	Capacitor 6.8 µF ±20 %	Solid Alu.	25 V
C114	5322 124 14081	Capacitor 6.8 µF ±20 %	Solid Alu.	25 V
C115	5322 124 41059	Capacitor 10000 µF ±20 %	Electrolyt.	35 V
C116	5322 124 10455	Capacitor 68 µF ±20 %	Solid Alu.	6.3 V
C117	4822 124 40209	Capacitor 220 µF ±20 %	Electrolyt.	25 V
C118...121	4822 121 41672	Capacitor 100 nF ±10 %	Foil	63 V
C122	5322 124 10455	Capacitor 68 µF ±20 %	Solid Alu.	6.3 V
C123	5322 124 10478	Capacitor 1.5 µF ±20 %	Solid Alu.	40 V
GR101	4822 130 30613	Diode BAW62	0.2 A	75 V
GR102	5322 130 34761	Bridge rectifier BY224	4.8 A	600 V
GR103	4822 130 34233	Diode BZX79/C5V1	Zener	0.4 W
GR104	4822 130 30613	Diode BAW62	0.2 A	75 V
GR105	5322 130 34761	Bridge rectifier BY224	4.8 A	600 V
GR106	4822 130 30613	Diode BAW62	0.2 A	75 V
GR107	5322 130 32031	Bridge rectifier SKB2/04L5A	1.4 A	400 V
GR108	5322 130 34761	Bridge rectifier BY224	4.8 A	600 V
GR109	4822 130 30613	Diode BAW62	0.2 A	75 V
IC101, 102	5322 209 86514	IC LM324 QUAD OP-AMP	Linear	
IC103	5322 209 80956	IC 79L05	0.1A	-5 V
R101	5322 116 55364	Resistor 196 kohm ±1 %	Metal Film	0.4 W
R102	5322 116 54721	Resistor 178 kohm ±1 %	Metal Film	0.4 W
R103	4822 116 51236	Resistor 1.1 kohm ±1 %	Metal Film	0.4 W
R104	5322 116 50474	Resistor 42.2 kohm ±1 %	Metal Film	0.4 W
R105	5322 116 55422	Resistor 365 ohm ±1 %	Metal Film	0.4 W
R106	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
R107	4822 116 51281	Resistor 5.62 kohm ±1 %	Metal Film	0.4 W

Power Supply, Unit 1 (Continued)

Pos. No.	Order No.	Description		
R108...110	5322 116 53071	Resistor 0.22 ohm ±5 %	Metal Film	0.25 W
R111	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R112...118	5322 116 53071	Resistor 0.22 ohm ±5 %	Metal Film	0.25 W
R119	5322 116 50515	Resistor 1.78 kohm ±1 %	Metal Film	0.4 W
R120	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
R121	5322 116 55422	Resistor 365 ohm ±1 %	Metal Film	0.4 W
R122	5322 116 54721	Resistor 178 kohm ±1 %	Metal Film	0.4 W
R123	5322 116 50767	Resistor 2.15 kohm ±1 %	Metal Film	0.4 W
R124	5322 116 50557	Resistor 46.4 kohm ±1 %	Metal Film	0.4 W
R125	5322 116 54646	Resistor 23.7 kohm ±1 %	Metal Film	0.4 W
R126	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R127	4822 116 51247	Resistor 3.32 kohm ±1 %	Metal Film	0.4 W
R128	5322 116 55422	Resistor 365 ohm ±1 %	Metal Film	0.4 W
R129	5322 116 54595	Resistor 5.11 kohm ±1 %	Metal Film	0.4 W
R130	5322 116 52123	Resistor 1.87 ±1 %	Metal Film	0.4 W
R131	4822 116 51268	Resistor 100 kohm ±1 %	Metal Film	0.4 W
R132...134	5322 116 53071	Resistor 0.22 ohm ±5 %	Metal Film	0.25 W
R135	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
R136	5322 116 54712	Resistor 147 kohm ±1 %	Metal Film	0.4 W
R137, 138	5322 116 55422	Resistor 365 ohm ±1 %	Metal Film	0.4 W
R139, 140	5322 116 54732	Resistor 237 kohm ±1 %	Metal Film	0.4 W
R141	5322 116 55369	Resistor 38.3 kohm ±1 %	Metal Film	0.4 W
R142	5322 116 54595	Resistor 5.11 kohm ±1 %	Metal Film	0.4 W
R143	5322 101 10619	Trim pot. 100 ohm ±10 %	Cermet	0.2 W
R144	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
R145	5322 116 55273	Resistor 196 ohm ±1 %	Metal Film	0.4 W
R146	5322 116 54008	Resistor 4.75 kohm ±1 %	Metal Film	0.4 W
R147	4822 116 51246	Resistor 3.01 kohm ±1 %	Metal Film	0.4 W
R148	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
SK1	See page 7-4	Mains switch		
T1	5422 146 21017	Mains transformer		
THF1	4822 252 20017	Thermal fuse,	0.8 A	115 °C
TS101	5322 130 44324	Transistor BD204 PNP	8 A	60 V
TS102	4822 130 40937	Transistor BC548B NPN	0.1 A	30 V
TS103	4822 130 44197	Transistor BC558B PNP	0.1 A	30 V
TS104, 105	5322 130 44325	Transistor BD203 NPN	8 A	60 V
TS106, 107	4822 130 44197	Transistor BC558B PNP	0.1 A	30 V
TS108	5322 130 44325	Transistor BD203 NPN	8 A	60 V
VL1	4822 253 30019	Fuse 800 mA Slow-blow, 5x20 mm (for 220 V)		
VL1	4822 253 30024	Fuse 1.6 A Slow-blow, 5x20 mm (for 110 V)		

Timing Board, Unit 2

Pos. No.	Order No.	Description		
BU201, 202	See page 7-4	Connector, BNC	Chassis mounted	
BU201...203	5322 267 30501	Connector, Mini-coax for PCB mounting		
BU203	5322 321 21586	Cable Assy, Mini-coax - Mini coax		130 mm
BU204	5322 267 50555	Connector 4455-AC	MOLEX	12 pin
BU205	5322 265 40431	Connector 4094-14	MOLEX	14-pin
BU206	5322 265 44057	Connector 22-03 2126	MOLEX	6-pin
BU207	5322 267 50556	Connector 4455-BC	MOLEX	7-pin
C200	5322 125 50049	Trim Capacitor 1.8-10 pF		300 V
C201	4822 122 31194	Capacitor 8.2 pF ±0.25 pF	Ceramic NP0	500 V
C202, 203	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C204	4822 122 30027	Capacitor 1 nF ±10 %	Ceramic	100 V
C205...207	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C208, 209	5322 124 10455	Capacitor 68 µF ±20 %	Solid Alu.	6.3 V
C210	4822 122 31056	Capacitor 12 pF ±2 %	Ceramic NP0	100 V
C211	4822 124 20977	Capacitor 15 µF ±10 %	Solid Alu.	16 V
C212	4822 122 31992	Capacitor 8.2 pF	Cer. N1500	500 V
C213	4822 122 31081	Capacitor 100 pF ±2 %	Cer. N750	100 V
C214	5322 121 50906	Capacitor 1 nF ±1 %	Polystyrene	63 V
C215	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C216	4822 122 31056	Capacitor 12 pF ±2 %	Ceramic NP0	100 V
C217	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C218	4822 122 30045	Capacitor 27 pF ±2 %	Ceramic NP0	100 V
C219	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C220	4822 122 31081	Capacitor 100 pF ±2 %	Cer. N750	100 V
C221	4822 122 31821	Capacitor 3.3 pF ±0.25 pF	Chip NP0	100 V
C222	4822 122 31348	Capacitor 120 pF ±2 %	Ceramic NP0	100 V
C223	5322 121 50965	Capacitor 1.5 nF ±1 %	Foil	63 V
C224	5322 121 50964	Capacitor 15 nF ±1 %	Polystyrene	63 V
C225	5322 121 42318	Capacitor 150 nF ±5 %	Polycarb.	100 V
C226	5322 124 10502	Capacitor 1.5 µF ±5 %	Tantal	25 V
C227	5322 124 10501	Capacitor 15 µF ±5 %	Tantal	3 V
C228	5322 124 10503	Capacitor 150 µF ±5 %	Tantal	6.3 V
C229	4822 122 32027	Capacitor 56 pF ±2 %	Ceramic NP0	100 V
C230	5322 122 32072	Capacitor 33 pF	Ceramic NP0	
C231	4822 122 31821	Capacitor 3.3 pF ±0.25 pF	Ceramic NP0	100 V
C232	4822 122 31348	Capacitor 120 pF ±2 %	Ceramic NP0	100 V
C233	5322 121 50965	Capacitor 1.5 nF ±1 %	Polystyrene	63 V
C234	5322 121 50964	Capacitor 15 nF ±1 %	Polystyrene	63 V
C235	5322 121 42318	Capacitor 150 nF ±5 %	Polycarb.	100 V
C236	5322 124 10502	Capacitor 1.5 µF ±5 %	Tantal	25 V

Timing Board, Unit 2 (Continued)

Pos. No.	Order No.	Description		
C237	5322 124 10501	Capacitor 15 µF ±5 %	Tantal	3 V
C238	5322 124 10503	Capacitor 150 µF ±5 %	Tantal	6.3 V
C239	4822 122 31056	Capacitor 12 pF ±2 % NP0	Ceramic	100 V
C240	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C243...245	5322 124 10455	Capacitor 68 µF ±20 %	Solid Alu.	6.3 V
C246	4822 124 20701	Capacitor 100 pF +50-10 %	Electrolyt.	25 V
C247	5322 124 10455	Capacitor 68 µF ±20 %	Solid Alu.	6.3 V
C248...253	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C254	5322 124 10455	Capacitor 68 µF ±20 %	Solid Alu.	6.3 V
C255...258	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C259	5322 124 10455	Capacitor 68 µF ±20 %	Solid Alu.	6.3 V
C260	4822 124 20977	Capacitor 15 µF ±10 %	Solid Alu.	16 V
C261	5322 124 10478	Capacitor 1.5 µF ±20 %	Solid Alu.	40 V
C262	4822 124 20945	Capacitor 33 µF ±40 %	Solid Alu.	10 V
C263...276	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C277	5322 122 32453	Capacitor 10 nF ±20 %	Ceramic	50 V
C278	5322 124 10455	Capacitor 68 µF ±20 %	Solid Alu.	6.3 V
C279	4822 124 20945	Capacitor 33 µF ±40 %	Solid Alu.	10 V
C280	4822 124 20701	Capacitor 100 pF +50-10 %	Electrolyt.	25 V
C281...285	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C286, 287	4822 124 20977	Capacitor 15 µF ±10 %	Solid Alu.	16 V
C0232	4822 122 32027	Capacitor 56 pF ±2 %	Ceramic NP0	100 V
GR201	4822 130 30594	Diode BAV10		60 V
GR202	5322 130 34865	Diode BZV46/1V5	Zener	0.4 W
GR203	4822 130 30594	Diode BAV10		60 V
GR204	5322 130 34865	Diode BZV46/1V5	Zener	0.4 W
GR205	4822 130 30613	Diode BAW62	0.2 A	75 V
GR206	5322 130 34865	Diode BZV46/1V5	Zener	0.4 W
GR207, 208	4822 130 30613	Diode BAW62	0.2 A	75 V
GR209	4822 130 34278	Diode BZX79/C6V8	Zener	0.4 W
GR210...213	5322 130 34283	Diode HP5082-2835		
GR214	4822 130 30613	Diode BAW62	0.2 A	75 V
GR217, 218	4822 130 30613	Diode BAW62	0.2 A	75 V
GR219	4822 130 30594	Diode BAV10		60 V
GR220, 221	4822 130 30613	Diode BAW62	0.2 A	75 V
GR222	4822 130 30594	Diode BAV10		60 V
GR223, 224	See page 7-4	LED	Yellow	5 mm
IC201...203	5322 209 85518	IC 100102P	ECL	
IC204	5322 209 83124	IC 100114P	ECL	
IC205...207	5322 209 85518	IC 100102P	ECL	

Timing Board, Unit 2 (Continued)

Pos. No.	Order No.	Description		
IC208	5322 209 83124	IC 100114P	ECL	
IC209, 210	5322 209 85518	IC 100102P	ECL	
IC211	5322 209 83124	IC 100114P	ECL	
IC212	5322 209 85518	IC 100102P	ECL	
IC221	5322 209 86441	IC 10116P	ECL	
IC222	5322 209 86203	IC 10138P	ECL	
IC231, 232	5322 209 84823	IC 74LS00N	TTL	
IC233...235	5322 209 83123	IC 74LS490N	TTL	
IC236	5322 209 83033	IC 74LS133N	TTL	
IC241, 242	5322 209 86201	IC CA3140E	CMOS	
IC244	5322 209 86201	IC CA3140E	CMOS	
IC247	5322 209 86201	IC CA3140E	CMOS	
IC251...254	5322 209 86514	IC LM324 QUAD OP-AMP	Linear	
L201...203	5322 158 10052	HF-choke		
L204, 205	4822 526 10025	Core, Ferroxcube, yellow		
L206	5322 158 10052	HF-choke		
L208...210	4822 526 10025	Core, Ferroxcube, yellow		
L211...215	5322 158 10052	HF-choke		
R201	5322 116 55207	Resistor 464 kohm ±1 %	Metal Film	0.4 W
R202	5322 116 55535	Resistor 1 Mohm ±1 %	Metal Film	0.4 W
R203	5322 116 55369	Resistor 38.3 kohm ±1 %	Metal Film	0.4 W
R204	5322 116 55535	Resistor 1 Mohm ±1 %	Metal Film	0.4 W
R205	5322 116 54442	Resistor 51.1 ohm ±1 %	Metal Film	0.4 W
R206, 207	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R208	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R209	5322 116 54511	Resistor 316 ohm ±1 %	Metal Film	0.4 W
R210	5322 116 50536	Resistor 464 ohm ±1 %	Metal Film	0.4 W
R211	5322 101 14194	Trim pot. LIN 10 ohm	Cermet	0.2 W
R212	5322 116 54694	Resistor 90.9 kohm ±1 %	Metal Film	0.4 W
R213	5322 116 50579	Resistor 3.16 kohm ±1 %	Metal Film	0.4 W
R214	5322 116 55535	Resistor 1 Mohm ±1 %	Metal Film	0.4 W
R215	5322 116 50557	Resistor 46.4 kohm ±1 %	Metal Film	0.4 W
R216	5322 116 55532	Resistor 750 kohm ±1 %	Metal Film	0.4 W
R217	4822 116 51265	Resistor 61.9 kohm ±1 %	Metal Film	0.4 W
R218	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
R219	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R220, 221	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
R222	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R223	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R224	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W

Timing Board, Unit 2 (Continued)

Pos. No.	Order No.	Description		
R226	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R227	4822 116 52199	Resistor 68 ohm ±5 %	Metal Film	0.2 W
R228	4822 116 52206	Resistor 120 ohm ±5 %	Metal Film	0.2 W
R229	5322 116 55368	Resistor 383 ohm ±1 %	Metal Film	0.4 W
R230...234	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R235	5322 116 55422	Resistor 365 ohm ±1 %	Metal Film	0.4 W
R236	5322 116 50729	Resistor 4.22 kohm ±1 %	Metal Film	0.4 W
R237	5322 116 50635	Resistor 1.47 kohm ±1%	Metal Film	0.4 W
R238	5322 116 50536	Resistor 464 ohm ±1 %	Metal Film	0.4 W
R239	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R240	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R241	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R242	5322 116 55369	Resistor 38.3 kohm ±1 %	Metal Film	0.4 W
R243	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R244	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R245	5322 116 54511	Resistor 316 ohm ±1 %	Metal Film	0.4 W
R248	4822 116 51234	Resistor 750 ohm ±1 %	Metal Film	0.4 W
R249	5322 101 10621	Trim pot. 20 kohm ±10 %	Cermet	0.2 W
R250	5322 116 50557	Resistor 46.4 kohm ±1 %	Metal Film	0.4 W
R251	5322 116 55359	Resistor 1.62 kohm ±1 %	Metal Film	0.4 W
R252	4822 116 51234	Resistor 750 ohm ±1 %	Metal Film	0.4 W
R255	5322 101 14194	Trim pot. LIN 10 kohm	Cermet	0.2 W
R257	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R258	5322 116 50536	Resistor 464 ohm ±1 %	Metal Film	0.4 W
R261	5322 116 55359	Resistor 1.62 kohm ±1 %	Metal Film	0.4 W
R262	5322 116 50452	Resistor 10 ohm ±1 %	Metal Film	0.4 W
R263	5322 116 54034	Resistor 31.6 ohm ±1 %	Metal Film	0.4 W
R264	5322 101 10542	Potentiometer 100 ohm ±10%	Cermet	0.2 W
R265	4822 116 51234	Resistor 750 ohm ±1 %	Metal Film	0.4 W
R266	5322 116 54034	Resistor 31.6 ohm ±1 %	Metal Film	0.4 W
R267	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R269	5322 116 50536	Resistor 464 ohm ±1 %	Metal Film	0.4 W
R271	5322 116 50672	Resistor 51.1 kohm ±1 %	Metal Film	0.4 W
R277, 278	5322 116 55369	Resistor 38.3 kohm ±1 %	Metal Film	0.4 W
R279, 280	4822 116 51234	Resistor 750 ohm ±1 %	Metal Film	0.4 W
R281	5322 116 54541	Resistor 825 ohm ±1 %	Metal Film	0.4 W
R282	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R288...290	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R291	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R292	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W

Timing Board, Unit 2 (Continued)

Pos. No.	Order No.	Description		
R293	5322 116 54541	Resistor 825 ohm ±1 %	Metal Film	0.4 W
R294	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R295...299	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R701	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R702	5322 116 54426	Resistor 121 ohm ±1 %	Metal Film	0.4 W
R703	5322 116 54511	Resistor 316 ohm ±1 %	Metal Film	0.4 W
R704	5322 116 55368	Resistor 383 ohm ±1 %	Metal Film	0.4 W
R705	5322 116 50767	Resistor 2.15 kohm ±1 %	Metal Film	0.4 W
R706...710	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R711	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R712	5322 116 54455	Resistor 68.1 ohm ±1 %	Metal Film	0.4 W
R713	5322 116 54511	Resistor 316 ohm ±1 %	Metal Film	0.4 W
R714	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R715	5322 116 50677	Resistor 21.5 ohm ±1 %	Metal Film	0.4 W
R716	5322 116 55368	Resistor 383 ohm ±1 %	Metal Film	0.4 W
R717	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R718	5322 116 55359	Resistor 1.62 kohm ±1 %	Metal Film	0.4 W
R719, 720	5322 116 55026	Resistor 330 ohm ±5 %	Metal Film	1.6 W
R721	5322 116 54459	Resistor 75 ohm ±1 %	Metal Film	0.4 W
R722	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R723	5322 116 54099	Resistor 8.25 ohm ±1 %	Metal Film	0.4 W
R724	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R725	5322 116 54608	Resistor 7.5 kohm ±1 %	Metal Film	0.4 W
R726	5322 116 50635	Resistor 1.47 kohm ±1 %	Metal Film	0.4 W
R727	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
R728	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R729	5322 116 54502	Resistor 261 ohm ±1 %	Metal Film	0.4 W
R730...732	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R733	5322 116 54442	Resistor 51.1 ohm ±1 %	Metal Film	0.4 W
R734	5322 101 14194	Trim pot. LIN 10 kohm	Cermet	0.2 W
R735	4822 116 51281	Resistor 5.62 kohm ±1 %	Metal Film	0.4 W
R736	5322 116 54442	Resistor 51.1 ohm ±1 %	Metal Film	0.4 W
R737	5322 116 54557	Resistor 1.21 kohm ±1 %	Metal Film	0.4 W
R738	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R739	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
R740	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R741	5322 101 14194	Trim pot. LIN 10 kohm	Cermet	0.2 W
R742	5322 116 54608	Resistor 7.5 kohm ±1 %	Metal Film	0.4 W
R743	5322 116 54426	Resistor 121 ohm ±1 %	Metal Film	0.4 W
R744	5322 116 54511	Resistor 316 ohm ±1 %	Metal Film	0.4 W

Timing Board, Unit 2 (Continued)

Pos. No.	Order No.	Description		
R745	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R748	5322 116 54541	Resistor 825 ohm ±1 %	Metal Film	0.4 W
R751	5322 116 55247	Resistor 422 kohm ±1 %	Metal Film	0.4 W
R753	5322 116 54541	Resistor 825 ohm ±1 %	Metal Film	0.4 W
R754	5322 116 55426	Resistor 6.19 kohm ±1 %	Metal Film	0.4 W
R755, 756	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R757	5322 101 10621	Trim pot. 20 kohm ±10 %	Cermet	0.2 W
R758	5322 116 50557	Resistor 46.4 kohm ±1 %	Metal Film	0.4 W
R760	5322 116 50671	Resistor 2.61 kohm ±1 %	Metal Film	0.4 W
R764-766	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
R767	5322 116 50536	Resistor 464 ohm ±1 %	Metal Film	0.4 W
R768	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R769	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R771	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R772	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
R773	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R774	5322 116 55426	Resistor 6.19 kohm ±1 %	Metal Film	0.4 W
R775	5322 116 50579	Resistor 3.16 kohm ±1 %	Metal Film	0.4 W
R776	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R777	5322 116 50677	Resistor 21.5 ohm ±1 %	Metal Film	0.4 W
R778	5322 116 55368	Resistor 383 ohm ±1 %	Metal Film	0.4 W
R779, 780	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R781	5322 116 54442	Resistor 51.1 ohm ±1 %	Metal Film	0.4 W
R782	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
R783	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R784, 785	5322 116 54442	Resistor 51.1 ohm ±1 %	Metal Film	0.4 W
R786	5322 101 14194	Trim pot. LIN 10 kohm	Cermet	0.2 W
R787	4822 116 51281	Resistor 5.62 kohm ±1 %	Metal Film	0.4 W
R788	5322 116 54451	Resistor 61.9 ohm ±1 %	Metal Film	0.4 W
R789	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
R790	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
R791	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R792	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R793	5322 101 14194	Trim pot. LIN 10 kohm	Cermet	0.2 W
R794	5322 116 54608	Resistor 7.5 kohm ±1 %	Metal Film	0.4 W
R795	5322 116 54426	Resistor 121 ohm ±1 %	Metal Film	0.4 W
R796	5322 116 54511	Resistor 316 ohm ±1%	Metal Film	0.4 W
R797	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R798	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
R799	5322 116 50729	Resistor 4.22 kohm ±1 %	Metal Film	0.4 W

Timing Board, Unit 2 (Continued)

Pos. No.	Order No.	Description		
R800	5322 116 55535	Resistor 1 Mohm ±1 %	Metal Film	
R801	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R802	5322 116 51398	Resistor 825 kohm ±1 %	Metal Film	0.4 W
R803	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R804	5322 116 55426	Resistor 6.19 kohm ±1 %	Metal Film	0.4 W
R805	5322 116 55247	Resistor 422 kohm ±1 %	Metal Film	0.4 W
R807	5322 116 54541	Resistor 825 ohm ±1 %	Metal Film	0.4 W
R808	5322 116 55279	Resistor 2.87 kohm ±1 %	Metal Film	0.4 W
R809, 810	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R811	5322 101 10621	Trim pot. 20 kohm ±10 %	Cermet	0.2 W
R812	5322 116 50557	Resistor 46.4 kohm ±1 %	Metal Film	0.4 W
R814	5322 116 55279	Resistor 2.87 kohm ±1 %	Metal Film	0.4 W
R816	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R817, 818	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R819, 820	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
R821	5322 116 50536	Resistor 464 ohm ±1 %	Metal Film	0.4 W
R822	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R823, 824	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R826	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
R827	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
SK201...203	See page 7-4	Switch, Rotary PM5786		
SK205...215	See page 7-4	Push switch		
TS201	5322 130 44418	Transistor,BF256A FET	N-channel	30 V
TS202	5322 130 44435	Transistor 2N5770 NPN	50 mA	15 V
TS203	5322 130 44845	Transistor 2N5771 PNP	50 mA	15 V
TS205	5322 130 44435	Transistor 2N5770 NPN	50 mA	15 V
TS208	4822 130 40937	Transistor BC548B NPN	0.1 A	30 V
TS209, 210	5322 130 42119	Transistor BFR90A NPN	25 mA	15 V
TS211, 212	5322 130 44845	Transistor 2N5771 PNP	50 mA	15 V
TS213, 214	5322 130 42244	Transistor BFR96S NPN	0.1 A	15 V
TS215	5322 130 44435	Transistor 2N5770 NPN	50 mA	15 V
TS217	5322 130 44435	Transistor 2N5770 NPN	50 mA	15 V
TS218, 219	4822 130 40937	Transistor BC548B NPN	0.1 A	30 V

Transition Time Board, Unit 3

Pos. No.	Order No.	Description		
BU301	5322 268 14152	Connector, 2391	MOLEX	9-pin
BU302	5322 267 54193	Connector, 4455-CC	MOLEX	17-pin
BU303	5322 267 30501	Connector, Mini-coax for PCB mounting		
BU303	See BU203	Cable Assy, Mini-coax - Mini coax		130 mm
BU304	5322 265 40432	Connector, 4030-12	MOLEX	12-pin
BU305	5322 321 21164	Flat cable assy. BU305 - BU405		100 mm
BU305	5322 265 40197	Connector 10 p double row		
C300	5322 122 32532	Capacitor 100 pF ±5 %	Chip NPO	50 V
C301	5322 124 40718	Capacitor 470 µF ±20 %	Electrolyt.	25 V
C302	5322 122 32532	Capacitor 100 pF ±5 %	Chip NPO	50 V
C303	5322 122 32531	Capacitor 1 nF ±5 %	Chip NPO	50 V
C304	4822 121 41677	Capacitor 10 nF ±10 %	Foil	220 V
C305	5322 121 40197	Capacitor 1 µF ±10 %	Polycarb.	100 V
C306	4822 121 41672	Capacitor 100 nF ±10 %	Foil	63 V
C307	5322 124 10499	Capacitor 10 µF	Tantal	16 V
C308	5322 124 10498	Capacitor 100 µF	Tantal	10 V
C309	5322 122 32453	Capacitor 10 nF ±20 %	Ceramic	50 V
C310	5322 124 10455	Capacitor 68 µF ±20 %	Solid Alu.	6.3 V
C311	4822 122 30114	Capacitor 2.2 nF ±10 %	Ceramic	100 V
C312	4822 122 31823	Capacitor 15 pF ±2 %	Chip NPO	100 V
C313	4822 124 20679	Capacitor 100 µF ±50 %	Electrolyt.	10 V
C317, 318	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C322	4822 124 20701	Capacitor 100 pF ±50 %	Electrolyt.	25 V
C323...327	5322 122 32453	Capacitor 10 nF ±20 %	Ceramic	50 V
C330	5322 124 10455	Capacitor 68 µF ±20 %	Solid Alu.	6.3 V
C331	5322 124 10455	Capacitor 68 µF ±20 %	Solid Alu.	6.3 V
C332, 333	4822 122 30045	Capacitor 27 pF ±2 %	Ceramic	100 V
C334	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C336...338	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C340...342	5322 122 32453	Capacitor 10 nF ±20 %	Ceramic	50 V
C343	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C345	5322 122 32453	Capacitor 10 nF ±20 %	Ceramic	50 V
C346	4822 124 20943	Capacitor 22 µF ±20 %	Solid Alu.	10 V
C347	4822 122 30094	Capacitor 220 pF ±10 %	Ceramic	100 V
C348	4822 122 30135	Capacitor 820 pF ±10 %	Ceramic	100 V
C349	4822 122 30094	Capacitor 220 pF ±10 %	Ceramic	100 V
GR301	4822 130 34174	Diode BZX79/B4V7	Zener	0.4 W
GR302, 303	5322 130 34283	Diode HP5082-2835		
GR304...307	4822 130 30613	Diode BAW62	0.2 A	75 V
GR308	4822 130 34382	Diode BZX79/C8V2	Zener	0.4 W

Transition Time Board, Unit 3 (Continued)

Pos. No.	Order No.	Description		
GR309	4822 130 32656	Diode BA483	0.1 A	35 V
GR310	4822 130 34382	Diode BZX79/C8V2	Zener	0.4 W
GR312	4822 130 34278	Diode BZX79/C6V8	Zener	0.4 W
GR313	4822 130 34382	Diode BZX79/C8V2	Zener	0.4 W
GR314	5322 130 34563	Diode BZX79/C2V7	Zener	0.4 W
GR317...319	4822 130 34174	Diode BZX79/B4V7	Zener	0.4 W
GR320	4822 130 30861	Diode BZX79/C7V5	Zener	0.4 W
GR321	4822 130 30613	Diode BAW62	0.2 A	75 V
GR323	4822 130 30613	Diode BAW62	0.2 A	75 V
GR324, 325	5322 130 34283	Diode HP5082-2835		
IC301	4822 209 80617	IC 741CP	Linear	
IC302, 303	5322 209 85518	IC 100102P	ECL	
IC304, 305	4822 209 80617	IC 741CP	Linear	
IC306, 307	5322 209 14121	IC 4053BP	CMOS	
IC308	4822 209 80617	IC 741CP	Linear	
IC309	5322 209 85484	IC 00012	Custom design	
L301	5322 158 10052	HF-choke		
L302	4822 526 10025	Core, Ferroxcube, yellow		
L303, 304	4822 526 10011	Ring		
L305	4822 526 10025	Core, Ferroxcube, yellow		
L306...308	5322 158 10052	HF-choke		
R301	4822 116 52175	Resistor 100 ohm ±5 %	Metal Film	0.2 W
R302, 303	4822 116 52222	Resistor 390 ohm ±5 %	Metal Film	0.2 W
R304...307	4822 116 51233	Resistor 681 ohm ±1 %	Metal Film	0.4 W
R308, 309	5322 116 54557	Resistor 1.21 kohm ±1 %	Metal Film	0.4 W
R310...312	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R313, 314	5322 116 55535	Resistor 1 Mohm ±1 %	Metal Film	0.4 W
R315	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R316	4822 116 52175	Resistor 100 ohm ±5 %	Metal Film	0.2 W
R317	5322 116 54557	Resistor 1.21 kohm ±1 %	Metal Film	0.4 W
R318	5322 116 54455	Resistor 68.1 ohm ±1 %	Metal Film	0.4 W
R319	5322 116 54576	Resistor 2.37 kohm ±1 %	Metal Film	0.4 W
R320	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R321	5322 116 54728	Resistor 215 kohm ±1 %	Metal Film	0.4 W
R322	4822 116 51231	Resistor 562 ohm ±1 %	Metal Film	0.4 W
R323	5322 116 50557	Resistor 46.4 kohm ±1 %	Metal Film	0.4 W
R324	5322 101 10622	Trim pot. 50 kohm ±10 %	Cermet	0.2 W
R325	5322 116 50579	Resistor 3.16 kohm ±1 %	Metal Film	0.4 W
R326	5322 116 54728	Resistor 215 kohm ±1 %	Metal Film	0.4 W
R327	5322 101 14254	Trim pot. LIN 10 kohm	Cermet	0.2 W

Transition Time Board, Unit 3 (Continued)

Pos. No.	Order No.	Description		
R328, 329	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
R330	5322 116 55535	Resistor 1 Mohm ±1 %	Metal Film	0.4 W
R331	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R332	5322 101 14254	Trim pot. LIN 10 kohm	Cermet 72X	0.2 W
R333	5322 116 55335	Resistor 383 kohm ±1 %	Metal Film	0.4 W
R334	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R335	5322 116 50767	Resistor 2.15 kohm ±1 %	Metal Film	0.4 W
R336	4822 116 51268	Resistor 100 kohm ±1 %	Metal Film	0.4 W
R337	4822 116 52175	Resistor 100 ohm ±5 %	Metal Film	0.2 W
R338	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
R339, 340	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R341	4822 116 51233	Resistor 681 ohm ±1 %	Metal Film	0.4 W
R342	5322 116 55563	Resistor 82.5 ohm ±1 %	Metal Film	1.0 W
R343, 344	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
R345	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R346	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R347	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R348	5322 116 55207	Resistor 464 kohm ±1 %	Metal Film	0.4 W
R349	5322 101 14254	Trim pot. LIN 10 kohm	Cermet 72X	0.2 W
R350	5322 116 55268	Resistor 316 kohm ±1 %	Metal Film	0.4 W
R351	5322 101 14254	Trim pot. LIN 10 kohm	Cermet 72X	0.2 W
R352	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R353	5322 116 50557	Resistor 46.4 kohm ±1 %	Metal Film	0.4 W
R354	5322 116 55374	Resistor 82.5 kohm ±1 %	Metal Film	0.4 W
R355	5322 116 54623	Resistor 11 kohm ±1 %	Metal Film	0.4 W
R356	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R357	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R358	5322 116 54632	Resistor 14.7 kohm ±1 %	Metal Film	0.4 W
R359	5322 116 54541	Resistor 825 ohm ±1 %	Metal Film	0.4 W
R360	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
R361	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R362	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R363	5322 116 50579	Resistor 3.16 kohm ±1 %	Metal Film	0.4 W
R364	5322 116 55207	Resistor 464 kohm ±1 %	Metal Film	0.4 W
R365	5322 101 14254	Trim pot. LIN 10 kohm	Cermet 72X	0.2 W
R366, 367	5322 116 54511	Resistor 316 ohm ±1 %	Metal Film	0.4 W
R368	5322 116 50767	Resistor 2.15 kohm ±1 %	Metal Film	0.4 W
R369, 370	4822 116 52217	Resistor 270 ohm ±5 %	Metal Film	0.2 W
R371	5322 116 54502	Resistor 261 ohm ±1 %	Metal Film	0.4 W
R372	4822 116 52206	Resistor 120 ohm ±5 %	Metal Film	0.2 W

Transition Time Board, Unit 3 (Continued)

Pos. No.	Order No.	Description		
R373	4822 116 52215	Resistor 220 ohm ±5 %	Metal Film	0.2 W
R374	4822 116 52206	Resistor 120 ohm ±5 %	Metal Film	0.2 W
R375	5322 116 50536	Resistor 464 ohm ±1 %	Metal Film	0.4 W
R376	4822 116 52215	Resistor 220 ohm ±5 %	Metal Film	0.2 W
R377	5322 116 50767	Resistor 2.15 kohm ±1 %	Metal Film	0.4 W
R378	5322 116 54576	Resistor 2.37 kohm ±1 %	Metal Film	0.4 W
R379, 380	4822 116 52206	Resistor 120 ohm ±5 %	Metal Film	0.2 W
R381	5322 116 54502	Resistor 261 ohm ±1 %	Metal Film	0.4 W
R382	4822 116 52206	Resistor 120 ohm ±5 %	Metal Film	0.2 W
R383	5322 116 50536	Resistor 464 ohm ±1 %	Metal Film	0.4 W
R384	4822 116 52215	Resistor 220 ohm ±5 %	Metal Film	0.2 W
R385	5322 116 54576	Resistor 2.37 kohm ±1 %	Metal Film	0.4 W
R386, 387	4822 116 52215	Resistor 220 ohm ±5 %	Metal Film	0.2 W
R388	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R389	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R390	5322 101 14299	Trim pot. 1 kohm ±10 %	Cermet 72X	0.2 W
R391	5322 116 55549	Resistor 100 ohm ±1 %	Metal Film	0.4 W
R392	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
R393	5322 116 55207	Resistor 464 kohm ±1 %	Metal Film	0.4 W
R394	5322 116 54712	Resistor 147 kohm ±1 %	Metal Film	0.4 W
R395	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R396	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
R397	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R398, 399	4822 116 52175	Resistor 100 ohm ±5 %	Metal Film	0.2 W
R551	5322 116 50677	Resistor 21.5 ohm ±1 %	Metal Film	0.4 W
R552	5322 101 10534	Trim pot. 20 kohm	Cermet 72X	0.2 W
R553	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R554	4822 116 52175	Resistor 100 ohm ±5 %	Metal Film	0.2 W
R555	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
R556	5322 116 55369	Resistor 38.3 kohm ±1 %	Metal Film	0.4 W
R557	5322 101 10534	Trim pot. 20 kohm	Cermet 72X	0.2 W
R558	4822 116 52211	Resistor 150 ohm ±5 %	Metal Film	0.2 W
R559, 560	4822 116 52197	Resistor 56 ohm ±5 %	Metal Film	0.2 W
R561	5322 116 50677	Resistor 21.5 ohm ±1 %	Metal Film	0.4 W
R562, 563	5322 116 55357	Resistor 10.7 kohm ±1 %	Metal Film	0.4 W
R564	4822 116 52175	Resistor 100 ohm ±5 %	Metal Film	0.2 W
R565, 566	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R567	5322 116 55369	Resistor 38.3 kohm ±1 %	Metal Film	0.4 W
R568	5322 116 50954	Resistor 38.3 ohm ±1 %	Metal Film	0.4 W
R570	5322 116 55335	Resistor 383 kohm ±1 %	Metal Film	0.4 W

Transition Time Board, Unit 3 (Continued)

Pos. No.	Order No.	Description			
R571...573	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W	
R574, 575	4822 116 52219	Resistor 330 ohm ±5 %	Metal Film	0.2 W	
R576	4822 116 52175	Resistor 100 ohm ±5 %	Metal Film	0.2 W	
R578	4822 116 51267	Resistor 75 kohm ±1 %	Metal Film	0.4 W	
R579	5322 116 50484	Resistor 4.64 kohm ±1%	Metal Film	0.4 W	
R580, 581	4822 116 52175	Resistor 100 ohm ±5 %	Metal Film	0.2 W	
R582	5322 116 52075	Resistor 3.16 ohm ±1 %	Metal Film	0.4 W	
R583	4822 116 52195	Resistor 47 ohm ±5 %	Metal Film	0.2 W	
R584	5322 101 10619	Trim pot. 100 ohm ±10 %	Cermet 72X	0.2 W	
R586	5322 116 55535	Resistor 1 Mohm ±1 %	Metal Film	0.4 W	
R587	5322 116 54721	Resistor 178 kohm ±1 %	Metal Film	0.4 W	
R588, 589	5322 101 10619	Trim pot. 100 ohm ±10 %	Cermet 72X	0.2 W	
R590, 591	4822 116 52197	Resistor 56 ohm ±5 %	Metal Film	0.2 W	
R592, 593	4822 116 52222	Resistor 390 ohm ±5 %	Metal Film	0.2 W	
R595	4822 116 52222	Resistor 390 ohm ±5 %	Metal Film	0.2 W	
SK301	See page 7-4	Switch, TRANSITION TIME			
TS301	5322 130 41683	Transistor BFQ51	PNP		
TS302, 303	5322 130 42145	Transistor BFR92	FET		
TS304	5322 130 42119	Transistor BFR90A	NPN	0.25 A	15 V
TS305...308	5322 130 34954	Transistor BFQ32S	PNP	0.1 A	15 V
TS309, 310	4822 130 44197	Transistor BC558B	PNP	0.1 A	30 V
TS311, 312	5322 130 42119	Transistor BFR90A	NPN	0.25 A	15 V
TS313	5322 130 42244	Transistor BFR96S	NPN	0.1 A	15 V
TS314	5322 130 41675	Transistor BFW92	NPN	50 mA	15 V
TS315	5322 130 42244	Transistor BFR96S	NPN	0.1 A	15 V
TS316	5322 130 41675	Transistor BFW92	NPN	50 mA	15 V
TS317, 318	5322 130 34954	Transistor BFQ32	PNP	75 mA	15 V
TS319	5322 130 41683	Transistor BFQ51	PNP		
TS320	5322 130 44845	Transistor 2N5771	PNP	50 mA	15 V
TS321	5322 130 42119	Transistor BFR90A	NPN	0.25 A	15 V
TS322	5322 130 41675	Transistor BFW92	NPN	50 mA	15 V
TS341, 342	5322 130 34954	Transistor BFQ32	PNP	75 mA	15 V

Output Amplifier Board, Unit 4

Pos. No.	Order No.	Description		
BU401	5322 267 54195	Connector 4455-AC	MOLEX	10-pin
BU402...404	5322 268 14033	Connector double row		16-pin
BU405	— See BU305 —	Flat cable assy. BU305 - BU405		100 mm
BU405	5322 265 40197	Connector double row		10-pin
BU501, 502	5322 267 30501	Connector, Mini-coax for PCB mounting		
C401, 402	4822 124 20701	Capacitor 100 µF +50 -10 %	Electrolyt.	25 V
C403, 404	5322 122 32453	Capacitor 10 nF ±20 %	Ceramic	50 V
C407	5322 122 32453	Capacitor 10 nF ±20 %	Ceramic	50 V
C408	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C409	5322 122 32453	Capacitor 10 nF ±20 %	Ceramic	50 V
C411	5322 122 32453	Capacitor 10 nF ±20 %	Ceramic	50 V
C412	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C413...417	5322 122 32453	Capacitor 10 nF ±20 %	Ceramic	50 V
C418	4822 122 31823	Capacitor 15 pF ±2 %	Chip NPO	100 V
C423...425	4822 124 20997	Capacitor 15 µF +40 -10 %	Solid Alu.	16 V
C426, 427	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C428, 429*	4822 122 31823	Capacitor 15 pF ±2 %	Ceramic	100 V
C428, 429*	4822 122 31063	Capacitor 22 pF ±2 %	Ceramic	100 V
C430	4822 122 30094	Capacitor 220 pF ±10 %	Ceramic	100 V
C431	4822 122 31348	Capacitor 120 pF ±2 %	Ceramic	100 V
C432*	4822 122 31125	Capacitor 4.7 nF +80 -20 %	Ceramic	63 V
C432*	4822 122 30055	Capacitor 33 pF	Ceramic	100 V
C433*	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
C433*	4822 122 31125	Capacitor 4.7 nF	Ceramic	100 V
C434	4822 122 31056	Capacitor 12 pF ±2 %	Ceramic NPO	100 V
C435	4822 122 30045	Capacitor 27 pF ±2 %	Ceramic NPO	100 V
GR401, 402	5322 130 33543	Diode 1N5341B/6.2	Zener	5 W
GR403, 404	5322 130 32812	Diode HP5082-2835		
GR405, 406	4822 130 34488	Diode BZX79/C11	Zener	0.4 W
GR407...410	4822 130 30594	Diode BAV10		60 V
GR411, 412	4822 130 34488	Diode BZX79/C11	Zener	0.4 W
GR413, 414	5322 130 32812	Diode HP5082-2835		
GR415	4822 130 34382	Diode BZX79/C8V2	Zener	0.4 W
IC401...409	4822 209 80617	IC 741CP	Linear	
L403, 404	5322 116 52929	Resistor Metal Film		

* Replace with the value originally fitted.

Output Amplifier Board, Unit 4 (Continued)

Pos. No.	Order No.	Description		
L405, 406	5322 158 10052	HF choke		
L407...410	5322 158 10243	HF-choke 100 µH ±10 %	Q=50	
R400	4822 116 52191	Resistor 33 ohm ±5 %	Metal Film	0.2 W
R401*	5322 116 54426	Resistor 121 ohm ±1 %	Metal Film	0.4 W
R401*	5322 116 55273	Resistor 196 ohm ±1 %	Metal Film	0.4 W
R402	5322 116 55416	Resistor 10 ohm ±5 %	Metal Film	1.6 W
R403, 404	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W
R405	5322 116 50672	Resistor 51.1 kohm ±1 %	Metal Film	0.4 W
R406	4822 116 52188	Resistor 27 ohm ±5 %	Metal Film	0.2 W
R407	4822 116 52215	Resistor 220 ohm ±5 %	Metal Film	0.2 W
R408	5322 116 55416	Resistor 10 ohm ±5 %	Metal Film	1.6 W
R409, 410	5322 116 50536	Resistor 464 ohm ±1 %	Metal Film	0.4 W
R411	5322 116 54474	Resistor 110 ohm ±1 %	Metal Film	0.4 W
R412	5322 116 54472	Resistor 105 ohm ±1 %	Metal Film	0.4 W
R413...415	4822 116 52188	Resistor 27 ohm ±5 %	Metal Film	0.2 W
R416	5322 116 55416	Resistor 10 ohm ±5 %	Metal Film	1.6 W
R417	4822 116 52215	Resistor 220 ohm ±5 %	Metal Film	0.2 W
R418	5322 116 54474	Resistor 110 ohm ±1 %	Metal Film	0.4 W
R419	5322 116 54472	Resistor 105 ohm ±1 %	Metal Film	0.4 W
R420	5322 116 50876	Resistor 26.1 ohm ±1 %	Metal Film	0.4 W
R421	4822 116 52182	Resistor 15 ohm ±5 %	Metal Film	0.2 W
R422	5322 116 50767	Resistor 2.15 kohm ±1 %	Metal Film	0.4 W
R423	5322 116 50635	Resistor 1.47 kohm ±1 %	Metal Film	0.4 W
R424	5322 101 10623	Trim pot. 2 kohm ±10 %	Cermet 72X	0.2 W
R425	5322 116 54637	Resistor 17.8 kohm ±1 %	Metal Film	0.4 W
R426	5322 101 14254	Trim pot. LIN 10 kohm	Cermet 72X	0.2 W
R427	5322 116 50579	Resistor 3.16 kohm ±1 %	Metal Film	0.4 W
R428, 429	5322 116 54446	Resistor 56.2 ohm ±1 %	Metal Film	1 W
R430	5322 101 10623	Trim pot. 2 kohm ±10 %	Cermet 72X	0.2 W
R431	5322 116 50635	Resistor 1.47 kohm ±1 %	Metal Film	0.4 W
R432	5322 101 10623	Trim pot. 2 kohm ±10 %	Cermet 72X	0.2 W
R433, 434	5322 116 55274	Resistor 215 ohm ±1 %	Metal Film	0.4 W
R435	5322 116 50492	Resistor 46.4 ohm ±1 %	Metal Film	0.4 W
R436	5322 101 10624	Trim pot. 50 ohm ±10 %	Cermet	0.2 W
R437, 438	5322 116 54632	Resistor 14.7 kohm ±1 %	Metal Film	0.4 W
R439, 440	5322 116 50767	Resistor 2.15 kohm ±1 %	Metal Film	0.4 W
R441, 442	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W
R443, 444	5322 116 50579	Resistor 3.16 kohm ±1 %	Metal Film	0.4 W
R445, 446	5322 101 10623	Trim pot. 2 kohm ±10 %	Cermet 72X	0.2 W

* Replace with the value originally fitted.

Output Amplifier Board, Unit 4 (Continued)

Pos. No.	Order No.	Description			
R447, 448	5322 116 50484	Resistor 4.64 kohm ±1 %	Metal Film	0.4 W	
R449	5322 101 10623	Trim pot. 2 kohm ±10 %	Cermet 72X	0.2 W	
R450, 451	5322 101 14254	Trim pot. LIN 10 kohm	Cermet 72X	0.2 W	
R452, 453	5322 116 51498	Resistor 8.25 kohm ±1 %	Metal Film	0.2 W	
R454	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W	
R455	5322 116 55367	Resistor 3.48 kohm ±1 %	Metal Film	0.4 W	
R456	4822 116 51144	Resistor 15 ohm ±5 %	Metal Film	1.6 W	
R457	4822 116 51252	Resistor 6.81 kohm ±1 %	Metal Film	0.4 W	
R458, 459	5322 116 54984	Resistor 68 ohm ±1 %	Metal Film	1.0 W	
R460	4822 116 51233	Resistor 681 ohm ±1 %	Metal Film	0.4 W	
R461, 462	5322 116 54632	Resistor 14.7 kohm ±1 %	Metal Film	0.4 W	
R463...468	4822 116 51233	Resistor 681 ohm ±1 %	Metal Film	0.4 W	
R469	4822 116 52191	Resistor 33 ohm ±5 %	Metal Film	0.2 W	
R470, 471	5322 116 50672	Resistor 51.1 kohm ±1 %	Metal Film	0.4 W	
R473, 474	5322 116 54984	Resistor 68 ohm ±1 %	Metal Film	1.0 W	
R476, 477	5322 116 54632	Resistor 14.7 kohm ±1 %	Metal Film	0.4 W	
R478	4822 116 51233	Resistor 681 ohm ±1 %	Metal Film	0.4 W	
R479	5322 116 52075	Resistor 3.16 ohm ±1 %	Metal Film	0.4 W	
R480, 481	4822 116 51233	Resistor 681 ohm ±1 %	Metal Film	0.4 W	
R482, 483	4822 116 51253	Resistor 10 kohm ±1 %	Metal Film	0.4 W	
R484	4822 116 52191	Resistor 33 ohm ±5 %	Metal Film	0.2 W	
R485, 486	5322 116 50672	Resistor 51.1 kohm ±1 %	Metal Film	0.4 W	
R487	4822 116 52191	Resistor 33 ohm ±5 %	Metal Film	0.2 W	
R488...491	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	0.4 W	
R492	5322 116 53471	Resistor 12.1 ohm ±1 %	Metal Film	1 W	1)
R492a	5322 116 52558	Resistor 3.83 ohm ±1 %	Metal Film	0.4 W	1)
R492b	5322 116 52558	Resistor 3.83 ohm ±1 %	Metal Film	0.4 W	1)
R492c	5322 116 51359	Resistor 4.64 ohm ±1 %	Metal Film	0.4 W	1)
R493	5322 116 50635	Resistor 1.47 kohm ±1 %	Metal Film	0.4 W	
R494	4822 116 51284	Resistor 9.09 kohm ±1 %	Metal Film	0.4 W	
R495	5322 116 51498	Resistor 8.25 kohm ±1 %	Metal Film	0.4 W	
R496	5322 101 10623	Trim pot. 2 kohm ±10 %	Cermet	0.2 W	
R497, 498*	5322 116 54511	Resistor 316 ohm ±1 %	Metal Film	0.4 W	
R497, 498*	5322 116 54455	Resistor 68.1 ohm ±1 %	Metal Film	0.4 W	
R499	4822 116 51235	Resistor 1 kohm ±1 %	Metal Film	.4 W	
R531	4822 116 52215	Resistor 220 ohm ±5 %	Metal Film	0.2 W	
R532*	4822 116 52222	Resistor 390 ohm ±5 %	Metal Film	0.2 W	
R532*	4822 116 52226	Resistor 560 ohm ±5 %	Metal Film	0.2 W	

* Replace with the value originally fitted.

1) Note that R492 in some units consists of three 0.4W resistors connected in series (R492a+R492b+R492c) instead of one power resistor.

Output Amplifier Board, Unit 4 (Continued)

Pos. No.	Order No.	Description		
R533*	4822 116 52219	Resistor 330 ohm ±5 %	Metal Film	0.2 W
R533*	4822 116 52222	Resistor 390 ohm ±5 %	Metal Film	0.2 W
SK22...24	See page 7-4	Push Switch OUTPUT MODE		
TS403...406	5322 130 42057	Transistor BFQ68 NPN	0.3 A	18 V
TS407, 408	4822 130 40824	Transistor BD136 PNP	1.5 A	45 V
TS409	4822 130 40937	Transistor BC548B NPN	0.1 A	30 V
TS410, 411	4822 130 40824	Transistor BD136 PNP	1.5 A	45 V
TS412	4822 130 40823	Transistor BD135 NPN	1.5 A	45 V
TS413	4822 130 40824	Transistor BD136 PNP	1.5 A	45 V
TS414	4822 130 40823	Transistor BD135 NPN	1.5 A	45 V

* Replace with the value originally fitted.

Attenuator Board, Unit 5

Pos. No.	Order No.	Description		
BU501, 502	See page 7-4	Connector for OUTPUT A and B, BNC		
BU501, 502	5322 267 30501	Connector, Mini-coax for PCB mounting		
L501, 502	5322 158 10052	HF-choke		
R501...503	5322 116 54492	Resistor 178 ohm ±1 %	Metal Film	0.4 W
R504	5322 116 54511	Resistor 316 ohm ±1 %	Metal Film	0.4 W
R505	5322 116 54482	Resistor 133 ohm ±1 %	Metal Film	0.4 W
R506	5322 116 54472	Resistor 105 ohm ±1 %	Metal Film	0.4 W
R507, 508	5322 116 54486	Resistor 150 ohm ±1 %	Metal Film	0.4 W
R509	5322 116 54426	Resistor 121 ohm ±1 %	Metal Film	0.4 W
R510...512	5322 116 54486	Resistor 150 ohm ±1 %	Metal Film	0.4 W
R513, 514	5322 116 54459	Resistor 75 ohm ±1 %	Metal Film	0.4 W
R515	5322 116 54486	Resistor 150 ohm ±1 %	Metal Film	0.4 W
R516...518	5322 116 54492	Resistor 178 ohm ±1 %	Metal Film	0.4 W
R519	5322 116 54511	Resistor 316 ohm ±1 %	Metal Film	0.4 W
R520	5322 116 54482	Resistor 133 ohm ±1 %	Metal Film	0.4 W
R521	5322 116 54472	Resistor 105 ohm ±1 %	Metal Film	0.4 W
R522, 523	5322 116 54486	Resistor 150 ohm ±1 %	Metal Film	0.4 W
R524	5322 116 54426	Resistor 121 ohm ±1 %	Metal Film	0.4 W
R525...527	5322 116 54486	Resistor 150 ohm ±1 %	Metal Film	0.4 W
R528, 529	5322 116 54459	Resistor 75 ohm ±1 %	Metal Film	0.4 W
R530	5322 116 54486	Resistor 150 ohm ±1 %	Metal Film	0.4 W
R531	4822 116 52213	Resistor 180 ohm ±5 %	Metal Film	0.2 W
SK19...21	See page 7-4	Push switch for ATTENUATOR		

Front Panel Board, Unit 6

Pos. No.	Order No.	Description		
BU601	5322 267 50557	Connector 4455-BC	MOLEX	14-pin
BU602	5322 265 40429	Connector 4094-17A	MOLEX	17-pin
BU603	5322 265 64028	Connector	MOLEX	10-pin
GR601...604	See page 7-4	LED CQV21-6	Red	5 mm
R601...605	See page 7-4	Potentiometer 100 kohm ±10 %	LOG	Cond. plastic
R606	See page 7-4	Potentiometer 1 kohm ±20 %	LIN	Cond. plastic
R607, 608	See page 7-4	Potentiometer 10 kohm ±20 %	LIN	Cond. plastic

Burst Control Board, Unit 7

Pos. No.	Order No.	Description		
BU701	5322 265 40182	Connector 3094-07F	MOLEX	7-pin
C701	4822 122 32027	Capacitor 56 pF ±2 %	Ceramic	100 V
C702	4822 122 32185	Capacitor 10 pF ±2 %	Ceramic NP0	100 V
C703...706	4822 122 31414	Capacitor 10 nF	Ceramic	100 V
IC701...704	5322 209 86203	IC 10138P	ECL	
IC705, 706	5322 209 85518	IC 100102P	ECL	
IC707...709	5322 116 53072	Res. network 100 ohm ±10 %	Metal Film	0.125 W
R701	5322 116 50536	Resistor 464 ohm ±1 %	Metal Film	0.4 W
R702	5322 116 50766	Resistor 147 ohm ±1 %	Metal Film	0.4 W
SK701	See page 7-4	Switch	Thumb-wheel	